OVERFISHING IN THE PHILIPPINE MARINE FISHERIES SECTOR: A Disaggregated Analysis

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ABSTRACT

Results of past studies indicated that the marine fisheries of the Philippines are already seriously overfished. The analyses conducted by the studies, however, were based on groupings of fish species. Moreover, the evaluation was conducted in an aggregated manner and did not study overfishing by specific economic sector or fish species.

The study investigated overfishing by looking into the problem by economic sector, i.e. commercial, municipal and overall marine fisheries; by gear, i.e. purse seine and other gears; and for 35 economically important marine species. The evaluation employed the Gordon-Schaefer (GS) and Fox models of marine overfishing and assumed single-species and multiple-species fisheries and constant prices for fish catch and fishing effort.

In addition, the study reviewed the economic theory and models of marine overfishing, empirical studies on overfishing, regulatory instruments to contain overfishing and experiences in local fishery administration. Aside from presenting background information, the reviews were intended to discuss management options for containing the overfishing problem.

Consistent with past works, the study found that overfishing exists in the commercial and municipal fisheries, individually, and in the marine fishery sector as a whole. Results also showed that if operated at optimal levels, the marine fisheries will generate substantial economic rents. For the overall marine fisheries, in particular, maximum economic rent of about P19.69 billion per year can be had at the maximum economic yield level.

The study further found that overexploitation does not exist only at the sectoral stage but also at the gear and species levels. Purse seine and other gears were shown to operate beyond optimal levels while several of the marine fish species were likewise found to be overfished.

To attain sustainable levels in marine fisheries, results of the study indicated that substantial reductions in fishing effort must be made. Specifically, for overall marine fisheries, fishing effort need to be lowered by about 65 percent to attain economic efficiency and by approximately 35 percent to generate biological sustainability. It was estimated that these reductions will mean that many fishermen, from about a quarter to half a million, will lose their fishery livelihood.

Based on the results of analysis, the study recommended that fishing effort in the marine fisheries must be decreased. To do so, options were considered, including raising the present rates for the license scheme or through direct fixing of the maximum amount of fishing effort that will be tolerated. Over the long term, however, the study suggested that a new management approach similar to the Individual Tradable Quota system being successfully employed in New Zealand fisheries, must be seriously considered.

On the potential employment impacts of reduction of fishing effort, the study suggested that a balance between efficiency and equity considerations must be exercised. Among others, those who will be displaced must be afforded assistance by the government in terms of skills training for gainful employment elsewhere and the provision of alternative employment.

OVERFISHING IN THE PHILIPPINE MARINE FISHERIES SECTOR: A DISAGGREGATED ANALYSIS

by

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CHAPTER I

INTRODUCTION

1.1. Overview of the Philippine Fisheries Sector

The Philippine fisheries sector is a significant contributor to the national economy. Total output of the sector approximately comprises five percent of the Gross National Product. Furthermore, fisheries production meets more than two-thirds of national animal protein consumption (Guerrero 1989; BAR 1991).

A brief review of production performance shows a steady growth of the fisheries sector over time **(Table 1)**. From 1981 to 1994, the sector posted an annual average growth rate of 3.30 percent, in terms of quantity, and 15.84 percent, in terms of value of production. Among the four subsectors, aquaculture and commercial fisheries grew the fastest, in quantity terms, while municipal marine fisheries and inland fisheries increased the slowest. In both quantity and value terms, aquaculture rose the fastest.

It was estimated that the fisheries sector employs about a million fishermen and fishfarmers (BFAR 1991). Of this number, 36 percent were in municipal marine fisheries, 29 percent were in commercial fisheries, 27 percent were in aquaculture and 8 percent were in inland fisheries **(Figure 1)**. Hence, the municipal marine fisheries was the most important subsector in terms of employment but commercial fisheries and aquaculture were not far behind.

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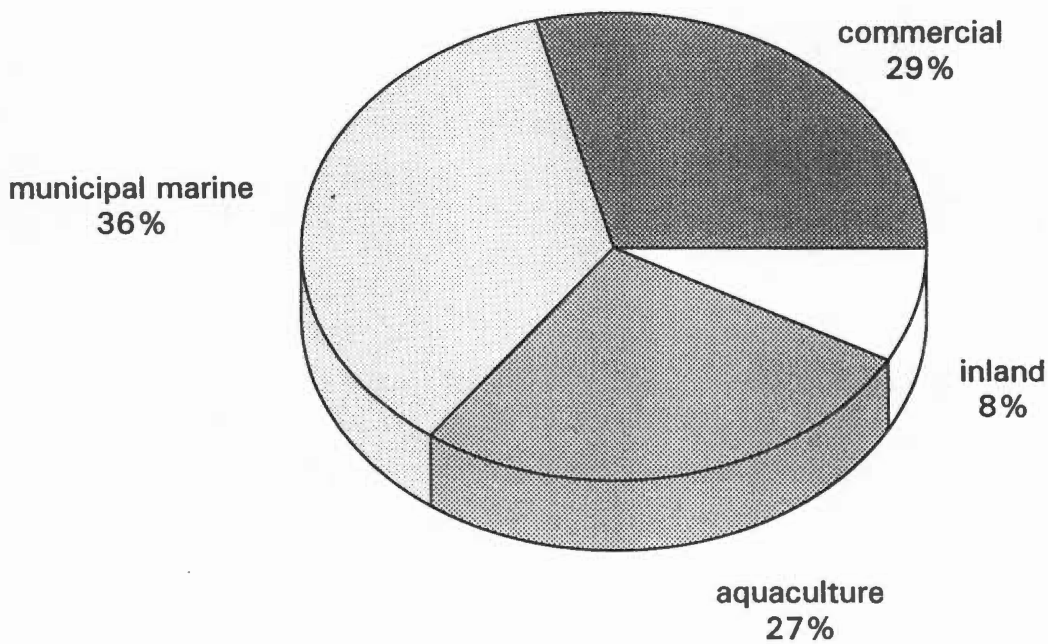
Table 1: Quantity (Thousand MT) and FOB Value (Million P) of Fish Production in the Philippines, by Sector, 1981-94

Year	All Sectors		Commercial		Municipal Marine		Aquaculture		Inland Fishing	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1981	1,774	13,955	495	4,125	710	8,264	340	2,866	229	700
1982	1,896	15,064	526	4,355	708	6,488	392	3,393	270	828
1983	2,110	18,982	519	4,643	771	7,463	445	4,799	375	2,077
1984	2,080	25,650	513	6,521	790	10,291	478	7,266	299	1,572
1985	2,052	31,297	512	7,857	785	12,796	495	8,724	260	1,920
1986	2,089	37,331	546	9,248	807	14,611	471	10,832	265	2,640
1987	2,213	37,350	591	9,821	616	14,217	561	11,421	245	1,891
1988	2,270	42,118	600	10,272	838	14,693	600	15,213	232	1,940
1989	2,371	45,094	637	11,033	883	16,182	629	15,673	222	2,206
1990	2,504	52,177	701	12,411	895	16,736	671	20,466	237	2,564
1991	2,599	60,034	760	15,245	914	19,614	692	22,656	233	2,519
1992	2,626	65,443	805	16,801	855	19,444	736	25,986	230	3,212
1993	2,647	71,058	845	18,365	803	20,118	772	30,508	227	2,067
1994	2,686	81,229	883	21,130	787	22,327	791	35,280	223	2,492
Ave. Annual Growth Rate (%)	3.30	14.84	4.62	13.76	0.88	10.77	6.87	22.01	0.69	16.87

Source: BAS. "Selected Fisheries Statistics".

Figure 1. Distribution of Employment in the Fishery Sector, 1990



Source of basic data: BFAR

It has been estimated also that when all backward and forward linkages are considered, about 12 percent of the total population of the Philippines were in one way or another dependent on fisheries related activities for their livelihood (Trinidad et al. 1993).

Finally, the fisheries sector has been a steady dollar earner for the country. In recent years, in particular, the exports of fisheries products have been growing at very high rates annually, especially in value terms **(Table 2).** While this was so, however, the imports of fishery products have been growing as well, and at even greater rates than do exports. Thus, in general, the country has been recording negative net exports over time, in quantity terms, although in value terms, it has been posting positive net exports.

1.2 Overfishing in the Marine Fisheries

Although the performance of the fisheries sector statistically looks impressive in terms of production, there has been a serious downside to it. Specifically, it has been argued that its marine component has been overfished already. It is feared that if the current marine fishing rate goes unabated, the marine fisheries can collapse as edible fish populations diminish and fish species are driven to near extinction.

Some local empirical economic studies on overfishing at the national level have been conducted and they suggest the acuteness of the overfishing problem in the marine fisheries (e.g. Silvestre and Pauly 1987; Dalzell et al. 1987; Trinidad et al. 1993; Padilla and De Guzman 1994). In summary, these studies indicated that the catch per unit effort (CPUE) in demersal, or bottom dwelling species, and small pelagic, or surface dwelling species, has been falling over the years, implying overfishing in these groupings of species.

The marine overfishing problem is illustrated in **Table 3.** In the past decades, the CPUE has steadily fallen so that by 1984, it was only approximately a third of the 1965 figures, for both small pelagic and demersal species. In contrast, effort spent on fishing has increased to greater than five times the 1965 levels. Evidently, then, while more and more effort has been dedicated in catching fish, the yield from fishing per unit of effort expended has been fast declining.

A graphical presentation of the situation, in **Figures 2 and 3,** however, shows that there were actually years when fishing effort declined. For small pelagic species, fishing effort decreased in the late sixties, early seventies, mid-seventies and mid-eighties. For the demersal species, effort fell in middle and late seventies. While this was so, on the other hand, there is no mistaking that the overall general trend of fishing effort has been increasing over the whole period.

A similar case can be observed for the catch per unit effort. As can be seen, the CPUE for small pelagic species had increased in the early and late seventies while that for demersal species had risen in the late sixties and middle seventies. Again, however, the overall trend of the CPUE has been falling over the whole period.

Table 2: Quantity (MT) and FOB Value (Million P) of Exports and Imports of Fishery Products by the Philippines, 1981-94

Year	Exports		Imports		Net Exports	
	Quantity	Value	Quantity	Value	Quantity	Value
1981	83,736	1,251	46,850	288	36,886	963
1982	68,265	1,120	83,445	444	(15,180)	676
1983	75,589	1,593	23,038	111	52,551	1,482
1984	63,055	2,179	6,097	50	56,958	2,129
1985	95,077	3,496	28,755	118	66,322	3,378
1986	101,453	4,883	69,085	386	32,368	4,497
1987	111,830	6,442	104,936	637	6,894	5,805
1988	128,903	9,599	164,575	1,312	(35,672)	8,287
1989	145,099	10,248	197,966	1,424	(52,867)	8,824
1990	143,038	11,529	196,115	1,854	(53,077)	9,675
1991	144,939	14,048	193,635	2,323	(48,696)	11,725
1992	131,915	11,090	221,545	2,496	(89,630)	8,594
1993	163,745	14,074	208,895	2,249	(45,150)	11,825
1994	172,080	15,027	241,194	2,505	(69,114)	12,522
Ave. Annual Growth Rate (%)	7.03	23.33	45.77	40.87	-41.90	26.99

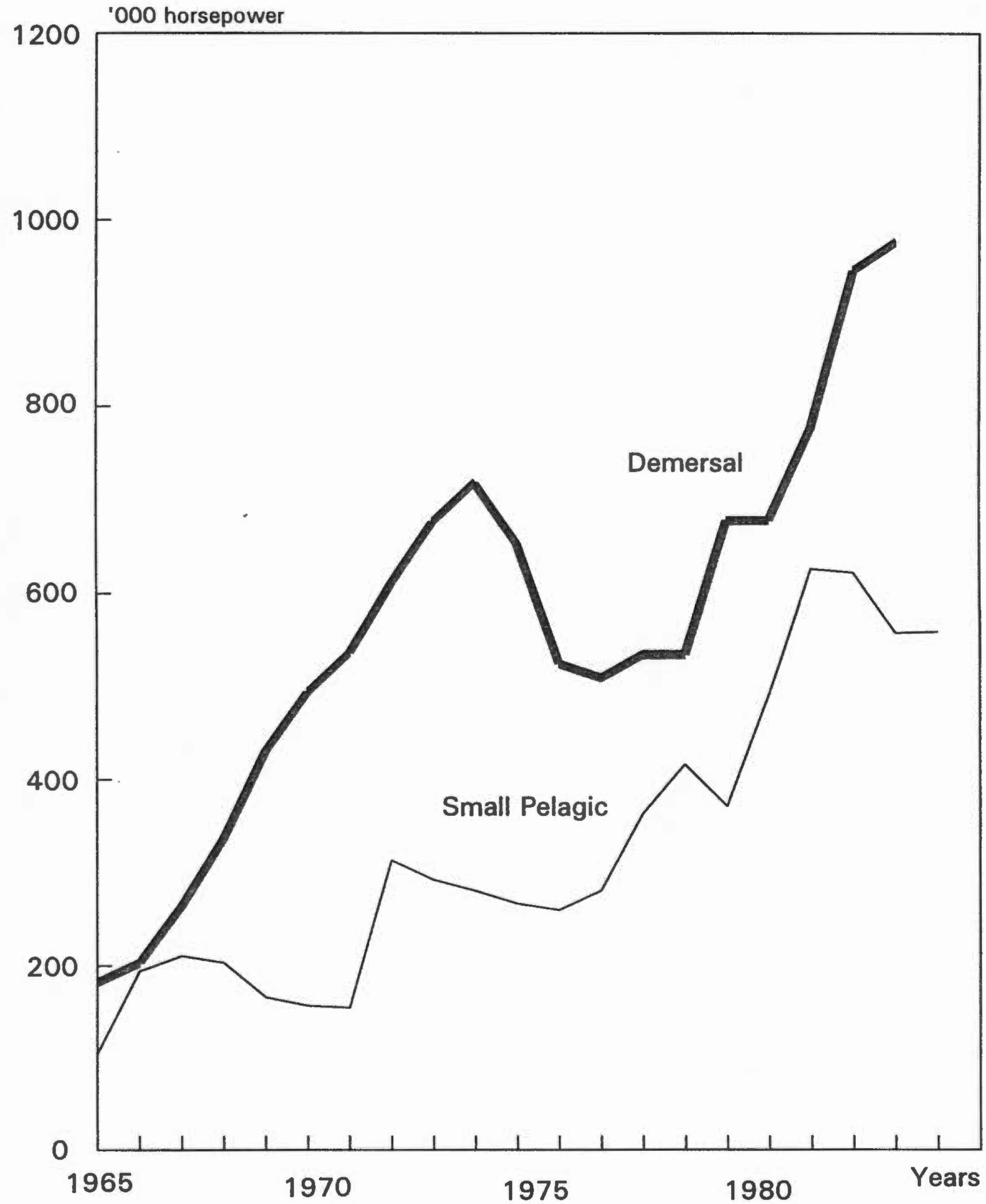
Source: BAS. "Selected Fisheries Statistics".

Table 3: Fishing Effort and Catch Per Unit Effort for Small Pelagic and Demersal Fish Species in the Philippines, 1965-85

Year	Small Pelagics Effort ('000 Hp)	Small Pelagics CPUE (Mt/Hp/yr	Demersals Effort ('000 Hp)	Demersals CPUE (Mt/Hp/yr)
1965	105	2.50	182	1.13
1966	194	2.00	203	1.09
1967	210	1.55	264	0.20
1968	203	1.76	337	0.89
1969	166	2.11	431	0.65
1970	157	2.69	494	0.56
1971	155	2.93	536	0.53
1972	313	2.08	610	0.54
1973	292	1.74	676	0.51
1974	280	1.82	718	0.52
1975	266	1.94	653	0.46
1976	259	2.01	524	0.69
1977	280	2.03	509	0.73
1978	363	1.64	534	0.68
1979	416	1.20	534	0.68
1980	371	1.21	677	0.55
1981	491	1.13	677	0.47
1982	625	0.92	777	0.47
1983	621	0.85	946	0.40
1984	557	0.84	976	0.42
1985	558	0.84	-	-
Ave. Annual Growth Rate (%)	11.93	-4.07	10.04	10.83

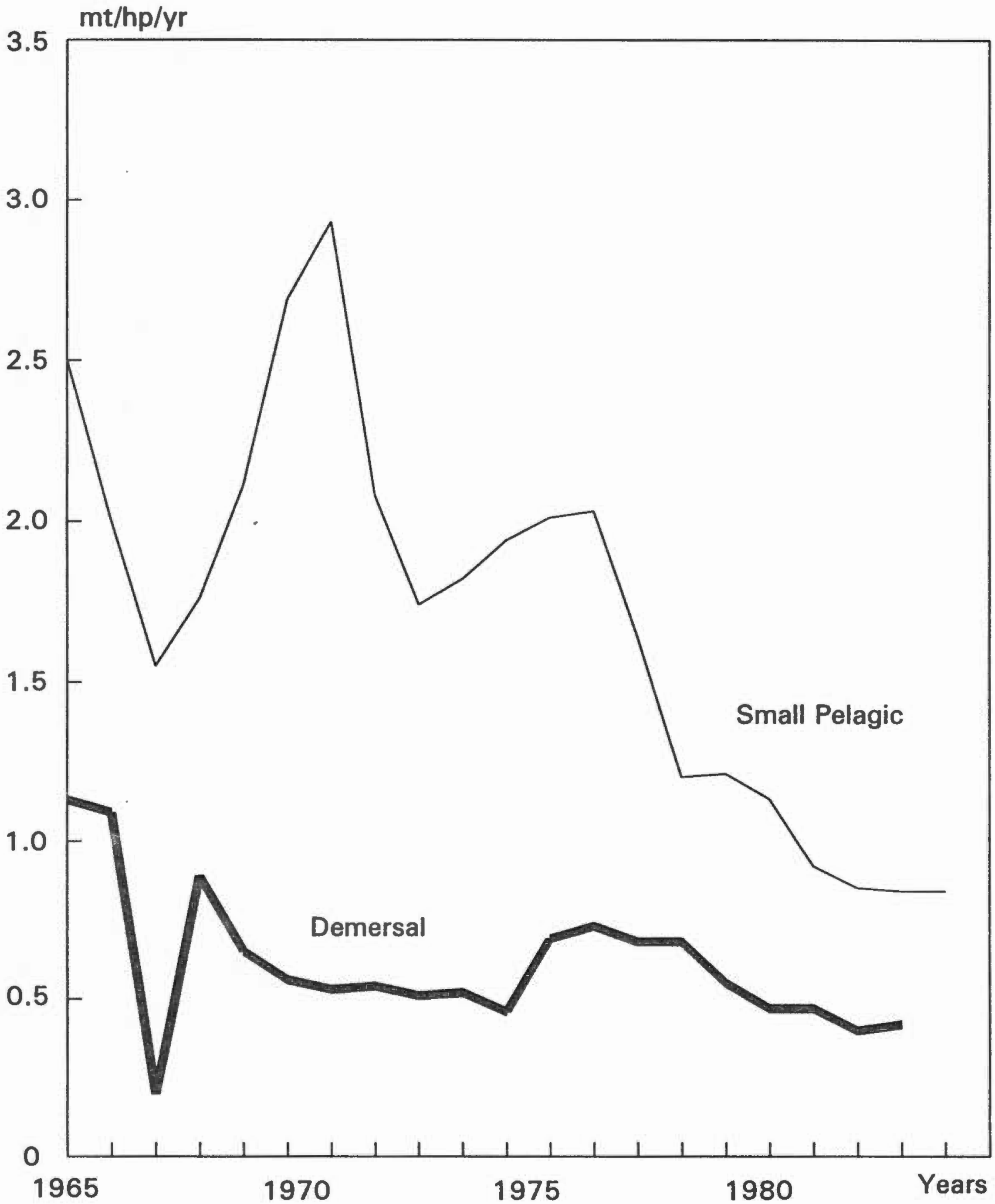
Sources: Silvestre and Pauly (1987) and Dalzell et al. (1987).

Figure 2. Total Fishing Effort for Small Pelagic and Demersal Fishes, 1965-1985



Source of basic data: Table 3.

Figure 3. Catch Per Unit Effort for Small Pelagic and Demersal Fishes, 1965-1985



Source of basic data: Table 3.

1.3 Research Gaps

Although studies have been conducted, there remain some research gaps related to overfishing in the marine fisheries sector which need to be addressed. For instance, an important limitation of past studies is that all were based on groupings of species, i.e. small pelagic and demersal fisheries. This approach may render the studies less useful for actual fisheries management and policy-making which are oftentimes sector-based, i.e. commercial fisheries and municipal fisheries.

Another important limitation of past studies is that they used throughout the assumption of a single or composite fish species in fisheries. Although this provides a beginning in analyzing overfishing, there is the need for a more disaggregated type of analysis, e.g. in terms of specific species. A third limitation of previous studies is that the social costs of a possible reduction in fishing effort to improve the management of resources, especially unemployment impacts of a reduction in fishing effort among fishermen, have not been considered. Yet, unemployment in a developing economy like the Philippines has always been of major consideration in policy-making.

1.4 Objectives of the Paper

The overall objective of this work is to investigate the issue of overfishing in the marine fisheries of the Philippines using a sectoral and disaggregated approach.

This effort is divided into two parts: the theoretical and institutional analysis (Part I) and the empirical estimation (Part II). The specific objectives of the theoretical and institutional analysis are as follows:

a) to review the basic theory of marine resource overfishing;

b) to review the different analytical models useful for analyzing marine resource overfishing;

c) to review the different empirical economic literature on overfishing at the national level in the Philippines and Southeast Asia;

d) to review the different regulatory instruments useful for containing the overfishing problem;

e) to review Philippine fisheries administration over time including the institutions and laws governing fisheries;

f) to review Philippine experience in the use of regulatory instruments for containing overfishing; and

g) to provide recommendations on how to analyze the overfishing problem in the marine fisheries sector.

The purpose of the review of the theory, models and literature is to develop analytical models which can be applied for empirical estimation. The review of regulatory instruments is done to get a better understanding of instruments and to determine which can be potentially applied to curve overfishing. The review of fishery institution and government experience with regulatory instruments is intended to get a picture of overall fishery administration vis a vis the government function as preserver of fisheries resources. The last objective provides the basis for doing the second part of the study.

The second part of this endeavor has the following objectives:

a) to construct time-series data on the parameters useful for the estimation of marine fisheries overfishing both at sectoral, i.e. commercial and municipal fisheries and overall marine fisheries, and disaggregated, i.e. individual gears and species, levels using secondary data;

b) to empirically estimate overfishing models using the constructed data;

c) to determine the biologically and economically optimal levels of exploitation in the commercial, municipal and overall marine fisheries;

d) to measure the maximum economic rent that can be generated from the commercial, municipal and overall marine fisheries;

e) to measure the employment impacts of reduction in fishing effort in the commercial, municipal and overall marine fisheries; and

f) to discuss the conclusions and provide some recommendations for the future conservation and development of the commercial, municipal and overall marine fisheries.

The second part of the paper is the central outcome of the study. Objectives (a) to (e) provides the findings that will be used to address objective (f) of the second part.

1.5 Sources of Data and Information

The sources of information for Part I are available literature on fishery institutions and theoretical and empirical literature on regulatory instruments and marine overfishing.

The theoretical literature on the regulatory instruments and on marine overfishing include fisheries and economics textbooks and journal articles. On the other hand, The empirical literature on overfishing are articles dealing on Philippine and Southeast Asian experience on the problem, specifically at the national level.

The institutional sources of the review materials for Part I were libraries of the Asian Development Bank (ADB), International Center for Living Aquatic Resource Management (ICLARM), University of the Philippines, Diliman Campus (UP Diliman), Department of Environment and Natural Resources (DENR), and Bureau of Fisheries and Aquatic Resources (BFAR). These institutions are located in Metro Manila.

For the second part of the work, the sources of data are the published indeces and unpublished files of the BFAR and the Bureau of Agricultural Statistics (BAS), which are under the Department of Agriculture (DA). These data sources and the data set generated will be discussed in more detail in Part II.

1.6 Organization of the Paper

The rest of the paper is organized as follows. In the first part, the economic theory of overfishing was discussed in Chapter 2 while overfishing models were reviewed in Chapter 3. In Chapter 4, empirical studies undertaken on overfishing were discussed while in chapter 5, the different regulatory instruments for containing the overfishing problem were reviewed. Chapter 6 discussed Philippine fishery institutions and laws and the experience in the utilization of regulatory instruments. The conclusions and recommendations of Part I were provided in Chapter 7.

In the second part, Chapter 8 discussed the empirical models used. Then, in Chapter 9, the data and methods for constructing the data were presented in detail. The results of the empirical estimation were shown in Chapter 10. The last chapter provided the conclusions and recommendations of Part II.

PART I: THEORETICAL AND INSTITUTIONAL ANALYSIS

CHAPTER II

THE BASIC THEORY OF MARINE RESOURCE OVERFISHING

Basically, there are two ways that overfishing can occur. The first is when fishermen employ excessive effort, in terms of time and other production inputs spent on fishing. The second is when they use destructive fishing gears and methods.

Both causes of overfishing can deplete the fisheries stock to dangerous levels over a given time. However, the current empirical literature generally emphasize only on excessive fishing effort as subject of analysis. An important constraint to an evaluation of destructive gears and methods is the difficulty encountered in generating information on the issue. Due to the illegal nature of destructive gears and methods in many countries, documentation of the actual levels of use and resource damage related to them has been virtually non-existent. This effort, then, follows tradition and concentrates only on the issue of overfishing in fisheries due to excessive fishing effort as the subject of analysis.

2.1 Kinds of Overfishing

Whether due to the employment of excessive fishing effort or use of destructive gears and techniques, however, overfishing can be classified in general into different categories (Pauly 1987). One form of overfishing is growth overfishing which occurs when the fish are caught even before they have a chance to grow. Here, too young fish are gathered below the required age for harvest.

Another type of overfishing is recruitment overfishing where the adult fish population is caught in large numbers so that fish reproduction is gravely impaired. The third kind of overfishing is ecosystem overfishing which happens when the decline in a once abundant fish stock due to fishing is not compensated for by an increase in the stocks of other species. Finally, the fourth kind of overfishing is economic which occurs when increases in fishing effort leads to profit levels which are below maximum.

Of the above types of overfishing, economic overfishing may be of most interest to fishery managers and planners. This is because the fisheries sector is primarily viewed by the society as an economic sector, i.e. food and income generating sector. As such, any disruption in the fisheries sector is eventually analyzed in terms of how much it impacts on the economic welfare of sectoral participants and society as a whole.

2.2 Biological Theory of Overfishing

While economic overfishing is what may concern the fishery managers and planners, the theory of overfishing actually commences with biological, and not economic, concepts. These biological concepts are reviewed below.

The basic biological story starts with the notion of a fishery resource, the sea, that is owned by no one and whose exploitation is open to everyone. Before the entrance of man into the fishery, the stock of fish, P, in the fishery grows at a net natural rate, r, between two time periods **(Figure 4).** This growth rate is equal to the recruitment of young fish joining the stock plus the growth of original fish in the stock less the natural fish mortality.

In theory, growth rate, r, is a function of the fish stock, P. Specifically, it is postulated that at very low levels of P, r is low. The r is low since at low P, there is not much fish in the stock to reproduce. As P rises and more fish reproduce, r also increases and continues to rise until eventually it reaches a maximum level. Beyond this maximum, further expansion of P leads to a declining r, due mainly to physical limits on growth imposed by the environment of the sea. Thus, an inverted U-shape of the r curve defines the relationship between r and P.

As man enters the fishery and starts to prey on the fish, the situation changes. By definition, r is now also the volume of fish that can be caught by man in a sustained way without affecting the size of the stock. It is sustainable because with all of the natural growth in the stock captured by man, total stock will not grow but remain constant over time.

Also, since man preys on fish and adds to their mortality, his activity may lead to the reduction of the fish stock. This implies that the relationship between fishing effort, E, and the fish stock is inverse. The lower E is, the higher is the equilibrium stock, P, and vice versa. The inverse relationship between E and P is shown in **Figure 5** where the stock curve is downward sloping.

When the relationship between the fish stock, P and the net natural growth, r, and that between the fish stock and fishing effort, E, are combined, a U-shaped relationship between r and E is derived **(Figure 6).** The relationship is one where at lower effort levels, the stock is high and this causes overcrowding and slow growth. As fishing effort rises, the stock declines and crowding is lessened, hence, causing faster growth. Finally, at too much effort, there is smaller stock to reproduce and growth slows down again.

In **Figure 6**, the point at which the level of effort yields the maximum r is the maximum sustainable point. Here, the fish catch by man is also the biological optimum, or the maximum sustainable yield (MSY) from the fishery.

Also from Figure 6, getting values of the CPUE and contrasting them against the values of effort generates the CPUE curve in **Figure 7.** The CPUE is falling, thus reflecting the decreasing efficiency in the fishery as effort intensifies.

Figure 4. Relationship Between Growth of Fish Population (r) and Fish Stock (P)

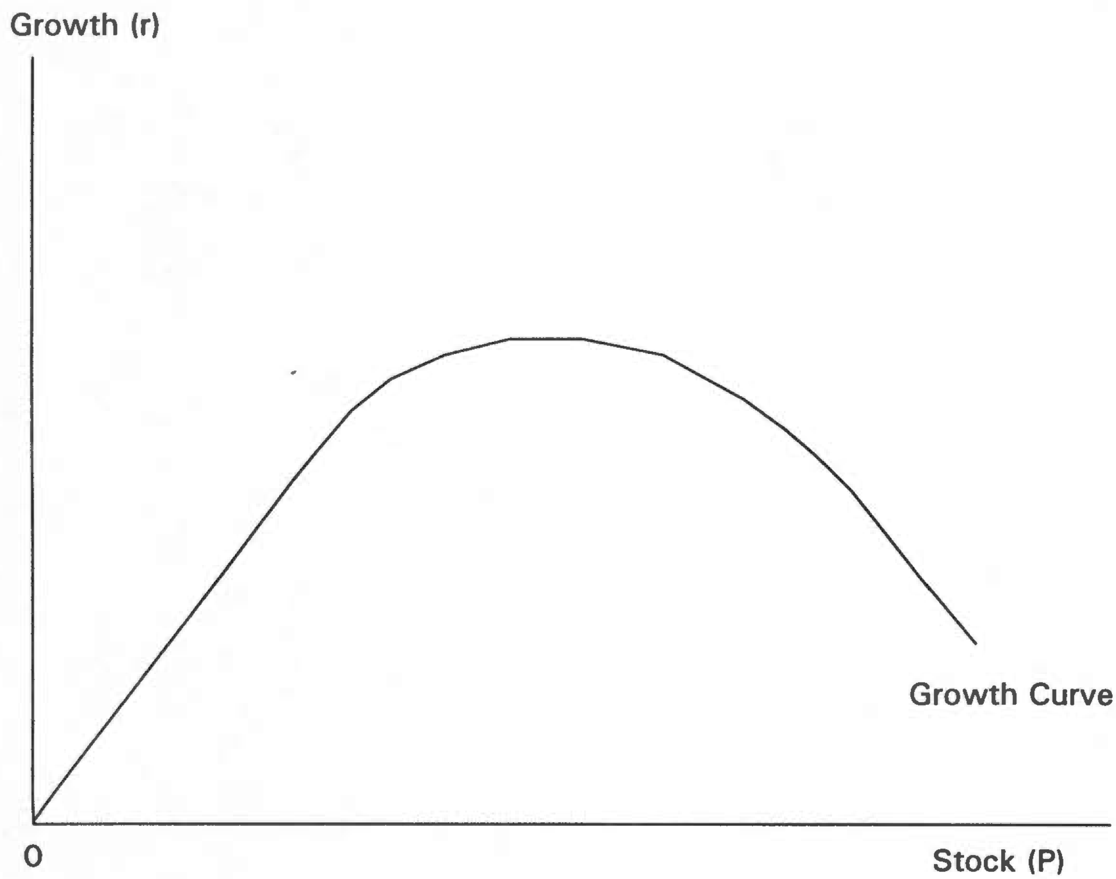


Figure 5. Relationship Between Fish Stock (P) and Fishing Effort (E)

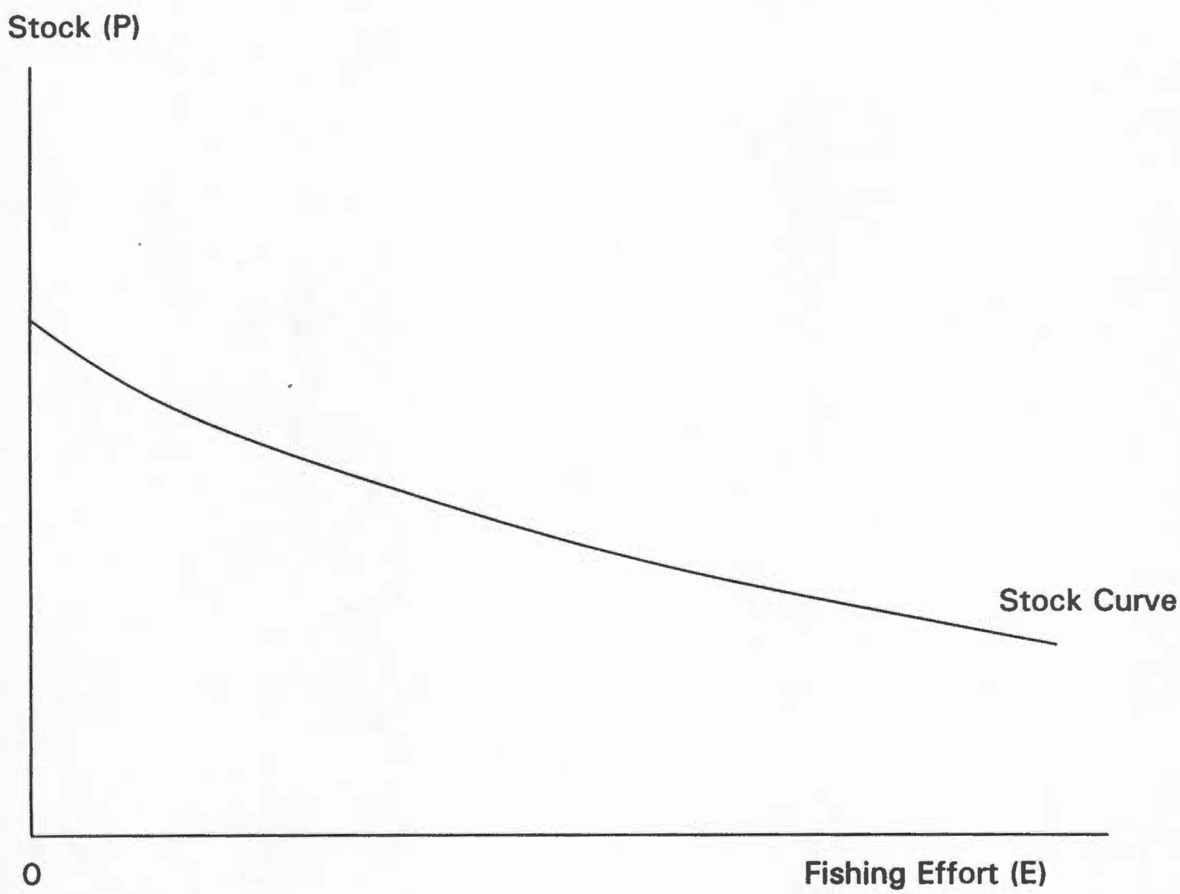


Figure 6. Relationship Between Fish Catch (Y) and Fishing Effort (E)

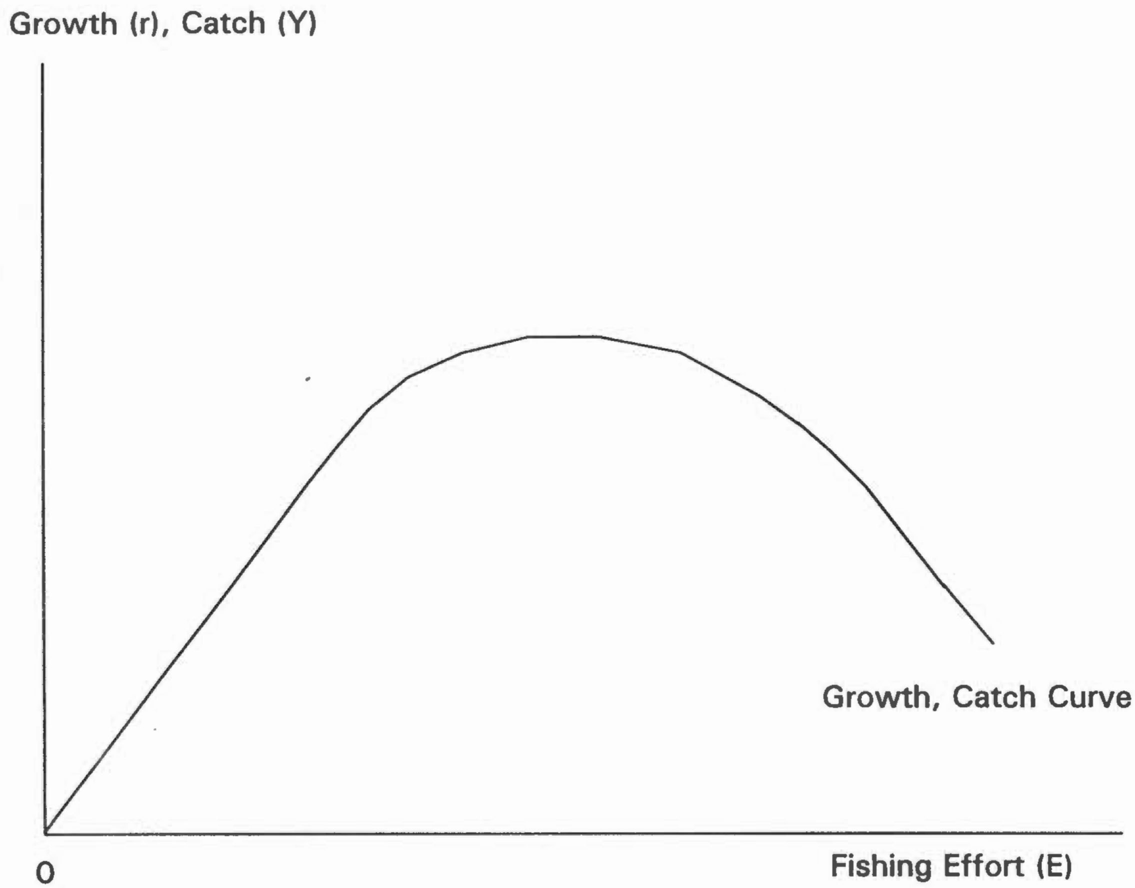
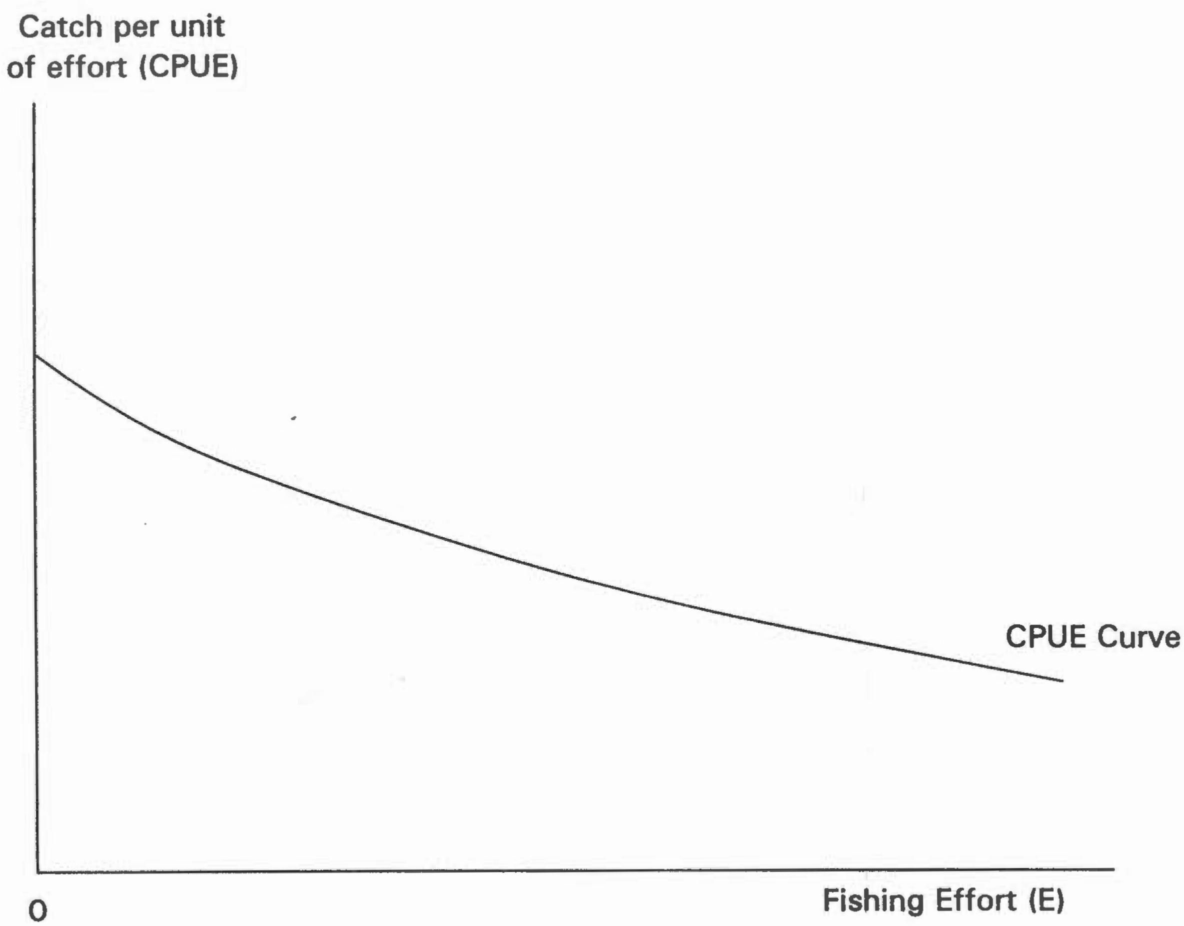


Figure 7. Relationship Between Catch Per Unit of Effort and Fishing Effort



2.3 Economic Theory of Overfishing

The biological model discussed above alone, however, will not be a sufficient basis for marine resource planning and management where economic concerns are important. Hence, the model above has to be transformed into an economic model.

In brief, the transformation is facilitated by incorporating prices for fish catch and fishing effort into the model to turn the biological parameters into economic parameters. To facilitate easy discussion, it is assumed below that the prices of fish and fishing effort are constant at all levels of catch and effort.

To generate the economic model from the biological model, the catch curve in **Figure 6** is converted into the total revenue or TR curve in **Figure 8**. This is done by simply multiplying catch by the fish price. As can be seen, the TR curve and the catch curve have similar shapes since given the constant fish price, the former is just a straightforward magnification of the latter, at all levels of effort.

After deriving the TR curve, the total cost or TC curve is generated by multiplying the fishing effort by the price of effort **(Figure 8).** With the fixed price for effort, this curve is linear and upward sloping with a slope that is equal to the constant price of effort.

From the TR and TC curves, average and marginal curves are derived **(Figure 9)**. The marginal revenue or MR curve represents the slope of the TR curve while the average revenue or AR curve provides the revenue per unit of effort. On the other hand, the marginal cost or MC curve represents the constant price of effort and is the same as the average cost or AC curve.

The economic model illustrated in **Figures 8 and 9** states that as effort, E, initially increases, TR also increases. However, TR rises at a decreasing rate. Continued increases in effort brings the level of fish catch first to the economic optimum, the maximum economic yield or MEY. At MEY, the standard economic condition for profit maximization, which is MR equals MC, is met **(see Figure 8).** Therefore, from the economic standpoint, MEY and E_{mey} are the most desirable yield and effort levels at which fishing may occur.

If the fishery is efficiently run, fishing should stop at MEY where profits are at maximum (The vertical difference between the TR and TC curve is greatest). However, with complete open-access, fishing continues beyond MEY as more and more fishermen, motivated by the existence of profits, get into the fishery. This situation pushes the level of fishing past the economic optimum and into the next optimum, the MSY. As shown earlier, MSY is the biological optimum and is the level of catch that is equal to the maximum net natural growth of the stock.

At the MSY level, positive profit still exist as TR remains greater than TC **(Figure 8).** This profit induces further fishing until, finally, the open access yield, or OAY, is reached. At OAY,

Figure 8. Total Revenue and Cost Curves and Cost Functions

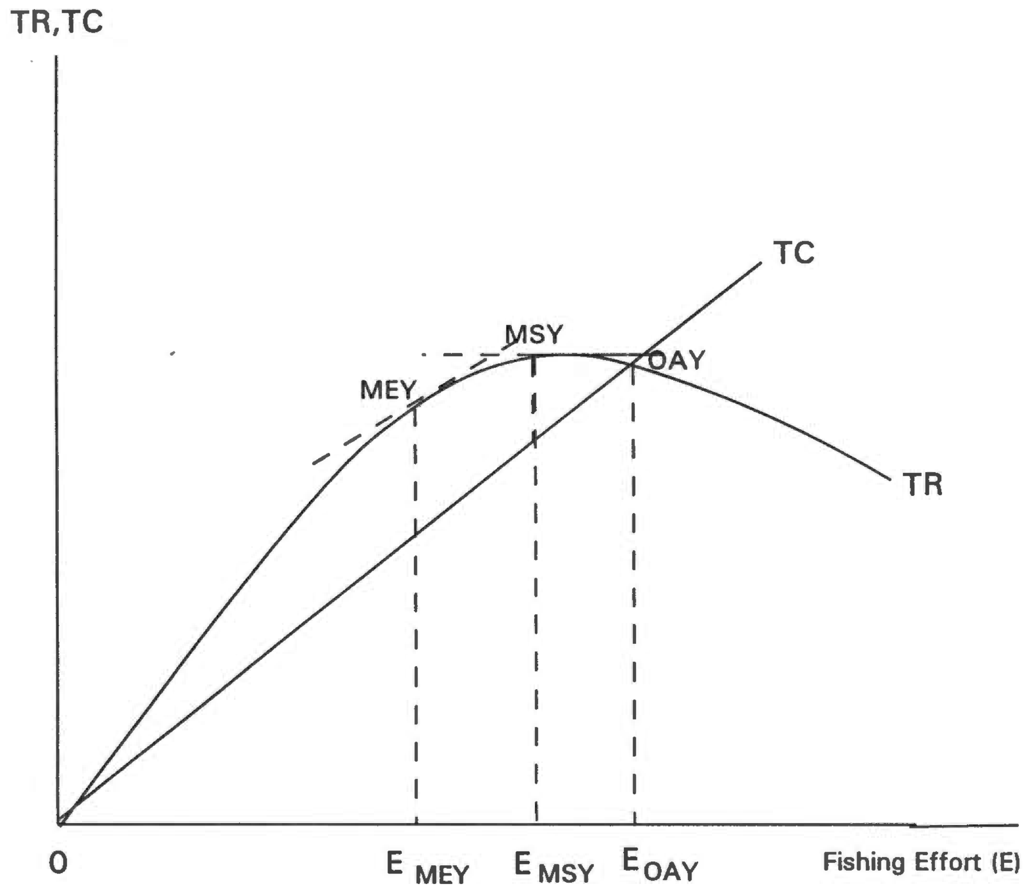
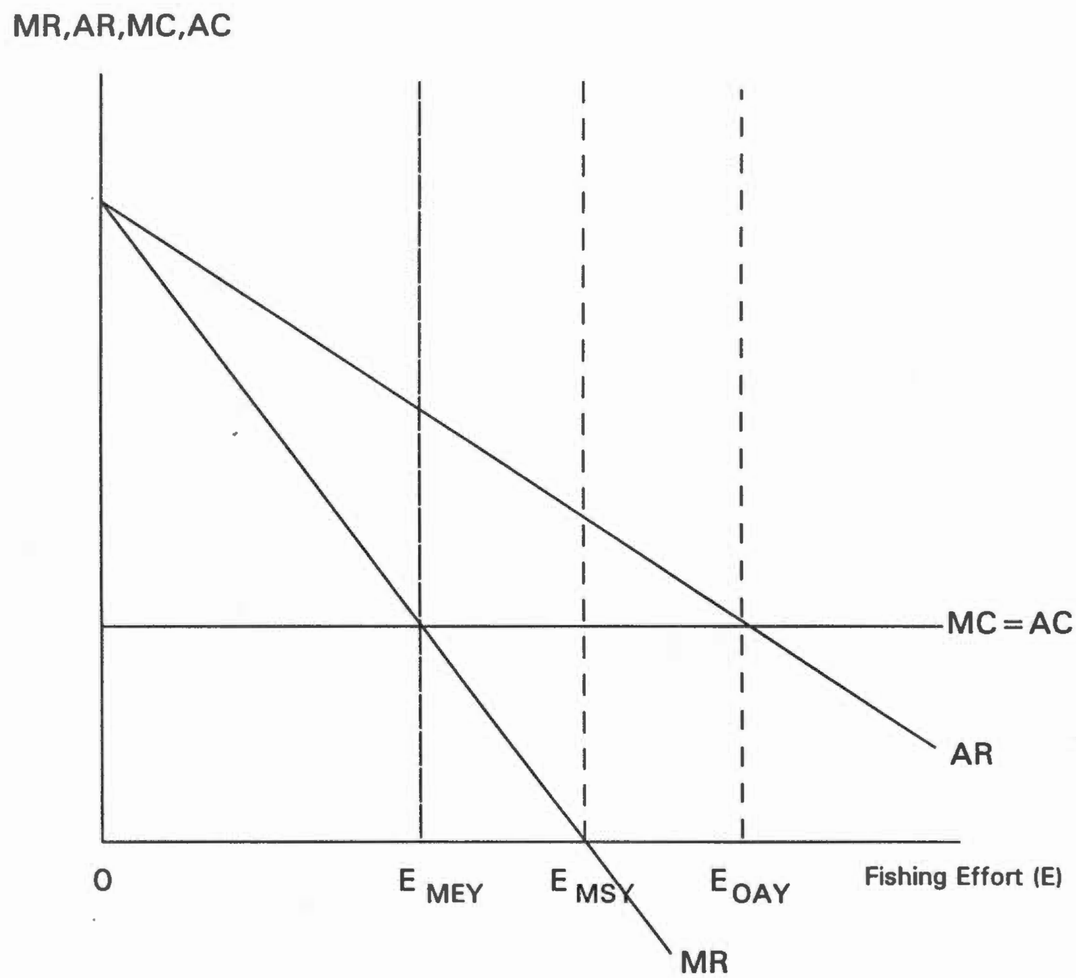


Figure 9. Marginal and Average Revenue Cost Curves



positive profits are gone and, without any incentive to continue fishing, further human predation stops. The OAY is the long-run equilibrium point of an open-access fishery.

To end this section, both biological and economic models are important in the analysis of overfishing. The former model gives the groundwork for the latter model. For fishery management, the latter model have a more relevant application.

The above models also show that unrestrained fishing effort due to open access will result to the inefficient overexploitation of resources in the fishery. The key then to the management of an overexploited fisheries sector is to control the level of fishing effort exerted by fishermen.

CHAPTER III

MODELS OF MARINE OVERFISHING

There are four general types of models which can be applied in the analysis of overfishing in the marine fisheries. These are the single species and constant price models, single species and variable price models, multiple species and constant price models and multiple species and variable price models. These models are discussed below.

3.1 Single Species and Constant Price Models

There are two main models falling under this category. Both are employed popularly in empirical research. These are the basic Gordon-Schaefer, or GS model, and the basic Fox Model. The basic GS model originated from Gordon (1953) and Schaefer (1954, 1957) while the basic Fox model has its beginnings in Fox (1970).

3.1.1 The Basic Gordon-Schaefer Model

The basic GS model is founded on the biological relationships explained in the theoretical discussion of overfishing in Chapter 2. In mathematical terms, the model starts out by assuming that between two points in time, the fish stock (P) rises at a natural rate (r) which is a single-valued function of the fish stock, or

$$r = dP/dt = f(P). \tag{1}$$

With fishing by man, the fish catch (Y) per unit of time, e.g. year, is a function of the fish stock and the amount of the effort spent by man on fishing (E), or

$$Y = g(P,E) \tag{2}$$

and that the fish stock is a function of fishing effort, or

$$P = h(E). \tag{3}$$

It follows from equations (1) and (2) that in an equilibrium condition,

$$r = Y \tag{4}$$

and this value of the catch and fish stock growth rate is the long-term yearly production for given levels of P and E.

To continue, the GS model argues that with the limited area of the sea, the fish stock can only grow to a maximum size (M) which is the environmental carrying capacity of the sea. Given M, the model considers as a good approximation of the growth rate of the stock shown in equation (1) the quadratic equation

$$r = a_1 P(M - P) \tag{5}$$

where a_1 and M are constants and growth in the fish stock is assumed proportional to the difference between the maximum carrying capacity and the stock. In addition, the model takes as an approximation of the catch in equation (2) the linear relationship

$$Y = a_2 EP \tag{6}$$

where a_2 is a constant.

Plugging equations (5) and (6) into equation (4) gets the equilibrium condition

$$a_1 P(M - P) = a_2 EP \tag{7}$$

or

$$P = M - (a_2 E / a_1) \tag{8}$$

which now explains fish stock as a linear function of effort. Also, plugging equation (8) into equation (6) gets

$$Y = a_2 ME - (a_2^2 / a_1) E^2 \tag{9}$$

or

$$Y/E = a_2M - (a_2^2/a_1)E \tag{10}$$

where catch in equation (9) is a quadratic function of effort and the average CPUE in equation (10) is a linear function of effort.

As explained in the theoretical discussion, the transformation of the biological model into an economic model requires the incorporation of prices for fishing effort and fish output into the model.

The basic transformation is to assume constant prices. Thus, the total cost function (TC) for fishing is of the following form

$$TC = j(E) = cE \tag{11}$$

where c is the constant price of fishing effort and TC is directly proportional to the amount of effort. Also, by assuming a constant price of fish caught (p), equation (9) can be transformed into the following total revenue function (TR)

$$TR = pY = p[a_2ME - (a_2^2/a_1)E^2] \tag{12}$$

or

$$TR = pa_2ME - p(a_2^2/a_1)E^2 \tag{13}$$

or

$$TR = b_1E - b_2E^2 \tag{14}$$

where b_1 and b_2 represent the combined constants of the equation.

From equations (11) and (14), the MSY, MEY and OAY can be attained. Using marginal and average concepts, the marginal cost (MC) and average cost (AC) functions from equation (11) are

$$MC = dTC/dE = c \tag{15}$$

and

$$AC = TC/E = cE/E = c. \tag{16}$$

On the other hand, based on equation (14), the MR and AR functions are

$$MR = dTR/dE = b_1 - 2b_2E \tag{17}$$

and

$$AR = \frac{TR}{E} = \frac{b_1E - b_2E^2}{E} = b_1 - b_2E. \tag{18}$$

As stated beforehand, the MEY is the production point where MR equals MC. Thus, from equations (15) and (17) is derived

$$MR = MC = b_1 - 2b_2E = c \tag{19}$$

or

$$E_{mey} = \frac{b_1 - c}{2b_2} \tag{20}$$

where E_{mey} is the fishing effort at MEY. Plugging equation (20) into equation (14) gets

$$MEY = b_1\left(\frac{b_1 - c}{2b_2}\right) - b_2\left(\frac{b_1 - c}{2b_2}\right)^2. \tag{21}$$

The MSY, on the other hand, is the point where MR is equal to 0. Equating equation (17) to 0 gets

$$MR = b_1 - 2b_2E = 0 \tag{22}$$

or

$$E_{msy} = b_1/2b_2 \tag{23}$$

where E_{msy} is the fishing effort at MSY. Combining equations (14) and (23) then gets

$$MSY = b_1(b_1/2b_2) - b_2(b_1/2b_2)^2 \tag{24}$$

or

$$MSY = \frac{b_2 b_1^2}{4b_2^2}. \tag{25}$$

Finally, OAY is the point where AR is equal to AC. Thus, equating equations (16) and (18) gets

$$AR = AC = b_1 - b_2 E = c \tag{26}$$

or

$$E_{oay} = \frac{b_1 - c}{b_2}. \tag{27}$$

where E_{oay} is the fishing effort at OAY. Plugging equation (27) into equation (14) gets

$$OAY = b_1\left(\frac{b_1 - c}{b_2}\right) - b_2\left(\frac{b_1 - c}{b_2}\right)^2. \tag{28}$$

With the prices for fish catch and fishing effort incorporated into the model, the MSY, MEY and OAY figures which will be derived based on the above equations will be in money terms. The derived values of the parameters need to be divided by the price of output, p,to express them in quantity terms.

A graphical discussion of the GS model is the same as that already illustrated in **Figures 8 and 9** in Chapter 2 except that the TR curve is quadratic in form and symmetric.

3.1.2 The Basic Fox Model

Another type of single species and constant price model is the basic Fox model. This model is similar to the GS model in that its initial biological assumptions are the same. Thus, mathematically, equations (1) to (4) also holds for the Fox model. The difference is that while the GS model assumes quadratic catch and TR functions in equations (9) and (14) and a linear CPUE function in equation (10), the Fox model assumes that biologically

$$Y = Ee^{c_1 + c_2 E} \tag{29}$$

and

$$Y/E = e^{c_1 + c_2 E} \tag{30}$$

where c_1 and c_2 are constants and both the total fish catch and average fish catch or CPUE are exponentially related to fishing effort.

Transforming the biological Fox model into an economic model follows similar procedures used beforehand for the GS model. Again assuming constant prices for fish catch and fishing effort, the TC, MC and AC functions are the same as those in equations (11), (15) and (16). On the other hand, the TR function becomes

$$TR = pY = p(Ee^{c_1 + c_2 E}) \tag{31}$$

while the MR and AR functions becomes

$$MR = \frac{dTR}{dE} = pe^{c_1 + c_2 E}(1 + Ec_2) \tag{32}$$

and

$$AR = \frac{TR}{E} = \frac{p(Ee^{c_1 + c_2 E})}{E} = pe^{c_1 + c_2 E}. \tag{33}$$

As before, MEY is the point where MR equals MC. Thus, from equations (15) and (32) is derived

$$MR = MC = pe^{c_1 + c_2 E}(1 + Ec_2) = c \tag{34}$$

or

$$(1 + E_{mey}C_2)(e^{c_1 + c_2 E_{mey}}) = \frac{c}{p}. \tag{35}$$

This value will then be plugged into equation (31) to derive MEY.

Also as before, MSY is the point where MR equals 0. Equating equation (32) to 0 gets

$$MR = pe^{c_1 + c_2 E}(1 + Ec_2) = 0 \tag{36}$$

or

$$(1+Ec_2)=0 \tag{37}$$

or

$$E_{msy}=-\frac{1}{c_2}. \tag{38}$$

Plugging equation (38) into equation (31) gets

$$MSY=p[-\frac{1}{c_2}e^{c_1+c_2(-\frac{1}{c_2})}] \tag{39}$$

or

$$MSY=-\frac{pe^{c_1-1}}{c_2}. \tag{40}$$

Finally, as before, the OAY is the point where AR equals AC. Thus, equating equations (16) and (33) gets

$$AR=AC=pe^{c_1+c_2E}=c \tag{41}$$

or

$$E_{oay}=\frac{\ln c-\ln p-c_1}{c_2}. \tag{42}$$

Plugging equation (42) into equation (31) gets

$$oay = p\left(\frac{\ln c - \ln p - c_1}{c_2}\right) \left(e^{\ln c - \ln p}\right). \tag{43}$$

As in the basic GS model, the MEY, MSY and OAY values derived for the Fox model are expressed in money terms. These values must be divided by the price of output, p, to generate the values in quantity terms.

A graphical presentation showing the differences between the GS and Fox models is shown in **Figure 10.** In terms of the relationship between catch and fishing effort, catch in the Fox model decreases relatively slower than in the GS model beyond a corresponding MSY. As to the relationship between the CPUE and fishing effort, CPUE in the Fox model also declines slower beyond its corresponding MSY and asymptotically approaches the horizontal effort axis.

3.2 Single Species and Variable Price Models

3.2.1 The Modified Gordon-Schaefer Model

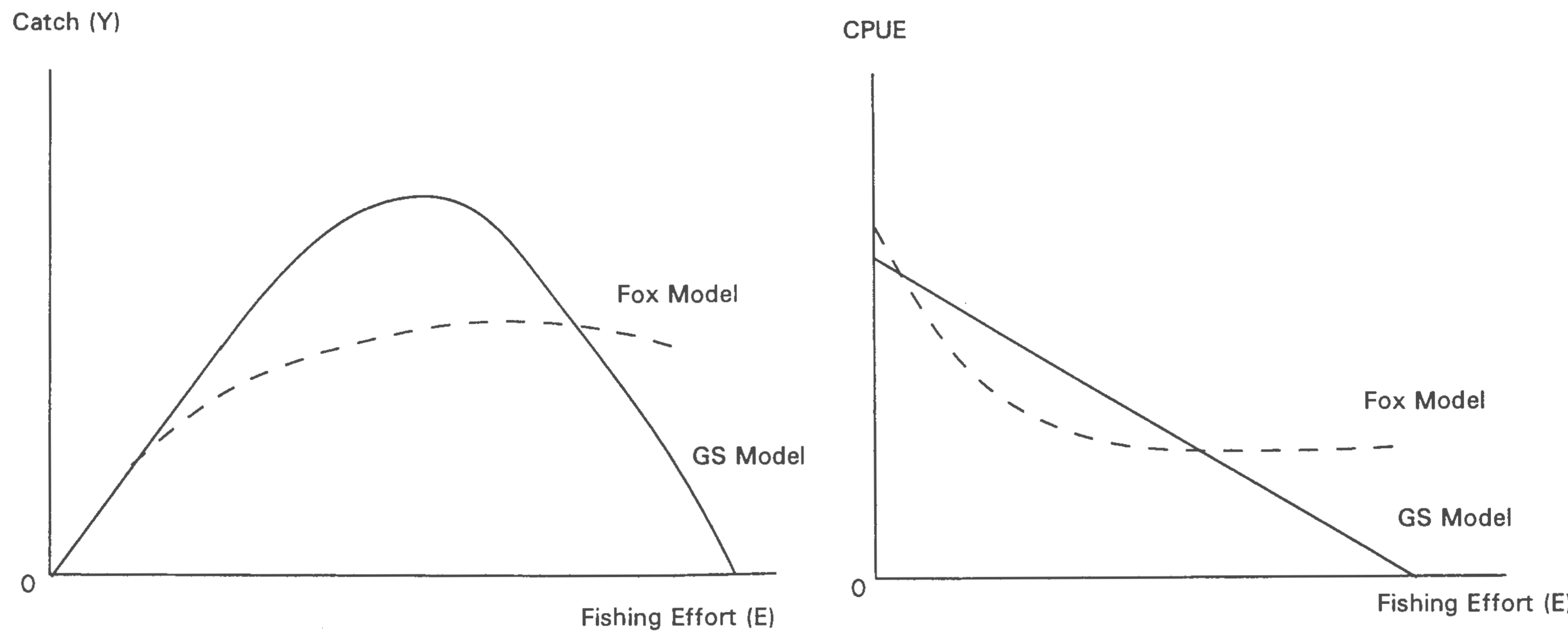
The GS model can be modified to do away with the assumption of fixed prices and instead assume that the price of fish changes over time while the price of effort remains constant. This model was already empirically applied by Panayotou and Jetanavanich (1987).

For this modified GS model, the basic biological conditions of the original model still holds. However, the economic portion of the model is changed. specifically, instead of describing revenues and costs in terms of fishing effort as done earlier, they are expressed in terms of fish catch (It will become apparent below that this transformation is necessary to make a connection between the variable fish price which is a function of fish catch and the revenues and costs which are previously functions of effort and not of catch). To do this, equation (9) is first converted into

$$Y = d_1 E - d_2 E^2 \tag{44}$$

where d_1 and d_2 are the combined constants. This catch equation is then reversed into the effort equation to get

Figure 10. Comparison of the Relationships Between Catch, CPUE and Effort in the Gordon-Schaefer and Fox Models



Source: Fox (1970)

$$E = \frac{[d_1 \pm (d_1^2 - 4d_2Y)^{1/2}]}{2d_2} \tag{45}$$

which is based on the quadratic formula and which, when plugged into equations (15) and (16), generates the following AC and MC functions

$$AC = \frac{TC}{Y} = \frac{cE}{Y} = \frac{c}{d_1 - d_2E} = \frac{2c}{d_1 \pm (d_1^2 - 4d_2Y)^{1/2}} \tag{46}$$

and

$$MC = \frac{dTC}{dY} = \frac{d(cE)}{dY} = \frac{c}{(d_1^2 - 4d_2Y)^{1/2}}. \tag{47}$$

Since it is now variable, fish price is then expressed as a function of fish catch or

$$p = k(Y). \tag{48}$$

Assuming a linear price function for equation (48) gets

$$p = e_1 - e_2Y \tag{49}$$

where e_1 and e_1 are constants and p is a decreasing function of catch.

With equations (48) and (49), the TR function in equation (12) becomes

$$TR = k(Y)Y \tag{50}$$

or

$$TR = pY = e_1 Y - e_2 Y^2 \tag{51}$$

and the AR and MR functions become

$$AR = TR/Y = e_1 - e_2 Y \tag{52}$$

and

$$MR = \frac{dTR}{dY} = e_1 - 2e_2 Y. \tag{53}$$

In contrast to the fixed price model, the MEY is now computed by equating price to MC to get

$$p = MC = e_1 - e_2 Y_{mey} = \frac{c}{(d_1^2 - 4d_2 Y_{mey})^{1/2}} \tag{54}$$

while MSY is derived by equating MR to AC to get

$$MR = AC = e_1 - 2e_2 Y_{msy} = \frac{2c}{d_1 \pm (d_1^2\ 4d_2 Y_{msy})^{1/2}} \tag{55}$$

and OAY is derived by equating AR to AC to get

$$AR = AC = e_1 - e_2 Y_{oay} = \frac{2c}{d_1 \pm (d_1^2 - 4d_2 Y_{oay})^{1/2}}. \tag{56}$$

Finally, if the fishery is monopolistically run instead of managed for the social good at MEY, the monopolistic position is where MR and MC are equated to get

$$MR = MC = e_1 - 2e_2 Y_{my} = \frac{c}{(d_1^2 - 4d_2 Y_{my})^{1/2}} \tag{57}$$

where MY is the monopolistic yield.

A graphical presentation using per unit curves of the single species and variable price Schaefer model is shown below in **Figure 11** reflecting the mathematically expressed relationships above.

3.2.2 The Modified Fox Model

Like the GS model, the Fox model can be modified by assuming that the price of fish catch is variable and the price of fishing effort is constant. Procedurally, the catch equation shown in equation (29) is again transformed into an effort equation to get

$$E = Y/e^{c_1 - c_2 E}. \tag{58}$$

From equation (58), the AC and MC curves become

$$AC = \frac{TC}{Y} = \frac{cE}{Ee^{c_1 - c_2 E}} = \frac{c}{e^{c_1 - c_2 E}} \tag{59}$$

and

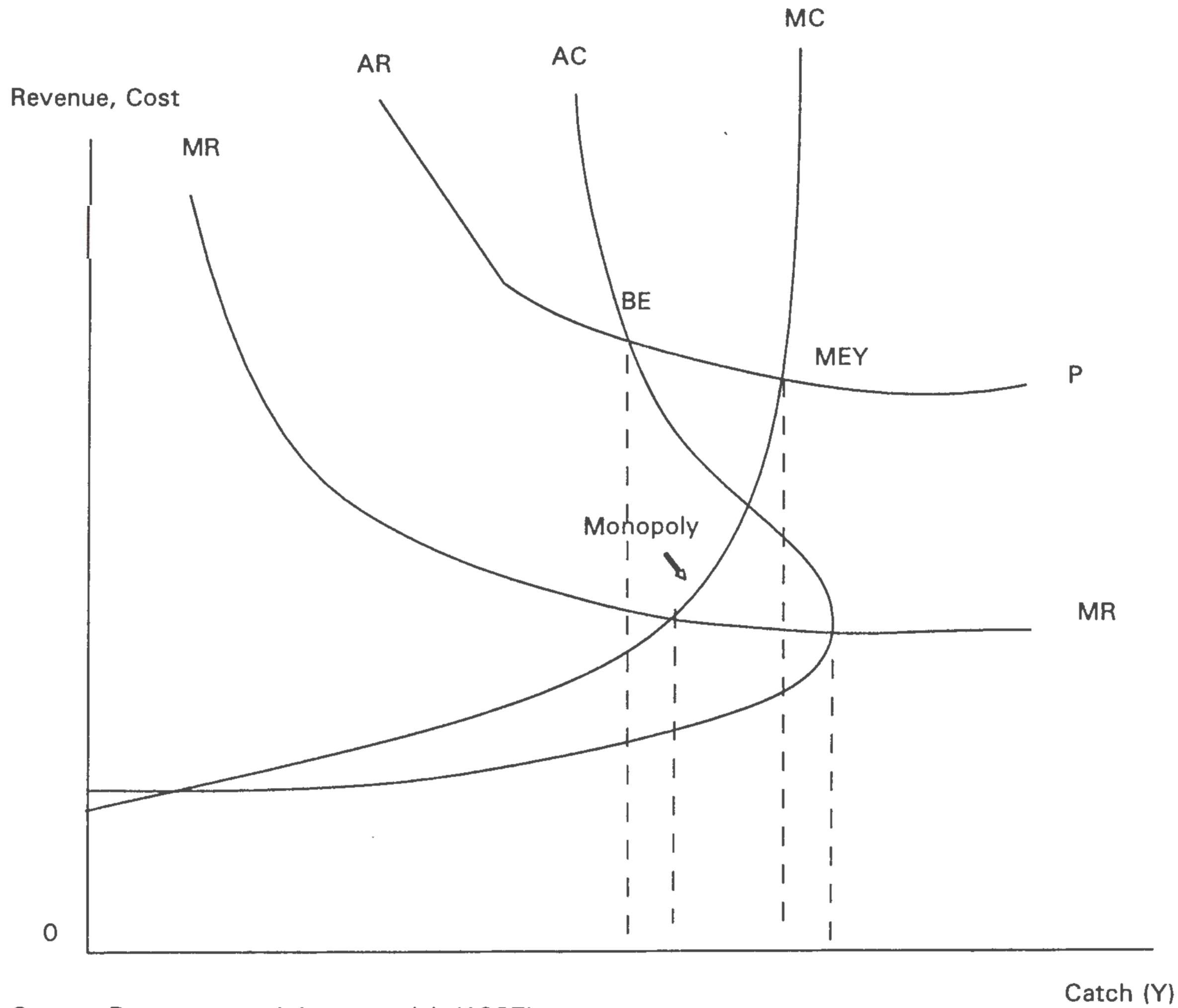
$$MC = \frac{dTC}{dY} = \frac{dcE}{dY} = \frac{c}{e^{c_1 - c_2 E}}. \tag{60}$$

Again assuming the linear price equation shown in equation (49), the MEY is generated by equating price to MC to get

$$p = MC = e_1 - e_2 Y_{mey} = \frac{c}{e^{c_1 - c_2 E_{mey}}}. \tag{61}$$

MSY is generated by equating MR to AC to get

Figure 11. A Variable Price Schaefer Model Indicating the Maximum Economic Yield (MEY), the Maximum Sustainable Yield (MSY), Monopoly Position and Bioeconomic Equilibrium (BE) Under Open Access



Source: Panayotou and Jetanavanich (1987)

$$MR = AC = e_1 - 2e_2 Y_{msy} = \frac{c}{e^{c_1 + c_2 E_{msy}}}. \tag{62}$$

OAY is derived by equating AR to AC to get

$$AR = AC = e_1 - e_2 Y_{oay} = \frac{c}{e^{c_1 + c_2 E_{oay}}}. \tag{63}$$

Lastly, if the fishery monopolistically operated, the optimal position is where MR and MC are equated to get

$$MR = MC = e_1 - 2e_2 Y_{my} = \frac{c}{e^{c_1 + c_2 E_{my}}}. \tag{64}$$

It is not known if the modified Fox model above has been used empirically. Furthermore, no graphical presentation of this model is available in the literature reviewed here.

3.3 Multiple Species and Fixed Price Models

Both the GS and Fox models may be extended further to take into account the multiple species nature of the marine fisheries, assuming constant prices for individual species. A narrative and graphical discussion of this type of model is found in Panayotou (1982). The following discussion of multiple species and fixed price models is now general, i.e. applicable to both the GS and Fox models.

Mathematically, in a multiple species fishery, total fish catch can be presented as

$$Y = \sum_{i=1}^{n} y_i(E) \tag{65}$$

where Y is total fish catch and y_i is fish catch of species i which is a function of total fishing effort, E.

Assuming constant prices for the individual species, equation (65) can be converted into a TR function of the form

$$TR = \sum_{i=1}^{n} p_i y_i(E) \tag{66}$$

where p_i is the fixed price of species i.

From equation (66) the MR and AR function are

$$MR = \sum_{i=1}^{n} mr_i(E) \tag{67}$$

and

$$AR = \sum_{i=1}^{n} ar_i(E). \tag{68}$$

With the constant price of fishing effort, the TC, MC and AC functions are the same as those shown previously in equations (11), (15) and (16). Therefore, MEY is the total yield level where the following condition is satisfied

$$MR = MC = \sum_{i=1}^{n} mr_i(E) = c. \tag{69}$$

On the other hand, MSY is the total yield level which meets the condition

$$MR = \sum_{i=1}^{n} mr_i(E) = 0 \tag{70}$$

while OAY is the total yield level that meets the condition

$$AR = AC = \sum_{i=1}^{n} ar_i(E) = c. \tag{71}$$

A graphical illustration of the individual species catch and total catch curves of the multiple species models is shown in **Figure 12.** Also, assuming fixed prices for each species, the individual and total revenue curves will have similar forms.

The total catch curve is the vertical summation of individual catch curves at different levels of total fishing effort. The behavior of the individual catch curves indicates that as total fishing effort is increased, the stocks of some commercial species, presumably those higher in the food chain, fall down. The species getting scarcer, however, are replaced by other species, presumably those below the food chain. Further increases in fishing effort ultimately leads to the loss of more and more commercial species in the fishery.

Finally, the choice of which model to use, the Schaefer Model or the Fox model, will decide the shape of the catch and TR curves for the individual species. The use of the Schaefer model implies quadratic and symmetric catch and TR curves while the employment of Fox model implies exponential curves for the individual species.

3.4 Multiple Species and Variable Prices Models

The multiple species model can be extended further by assuming that prices of individual species catch are not constant but varies with the level of catch of the species. No study has yet conducted this kind of model, however. Below the multiple species and fixed prices model is summarized, again by way of generalization.

As in the case of the single species and variable price model, in the multiple species and variable prices models the revenues and costs are again described not in terms of effort but in terms of catch. Specifically, the variable price of the individual species is expressed as

$$p_i = f_1 + f_2 y_i \tag{72}$$

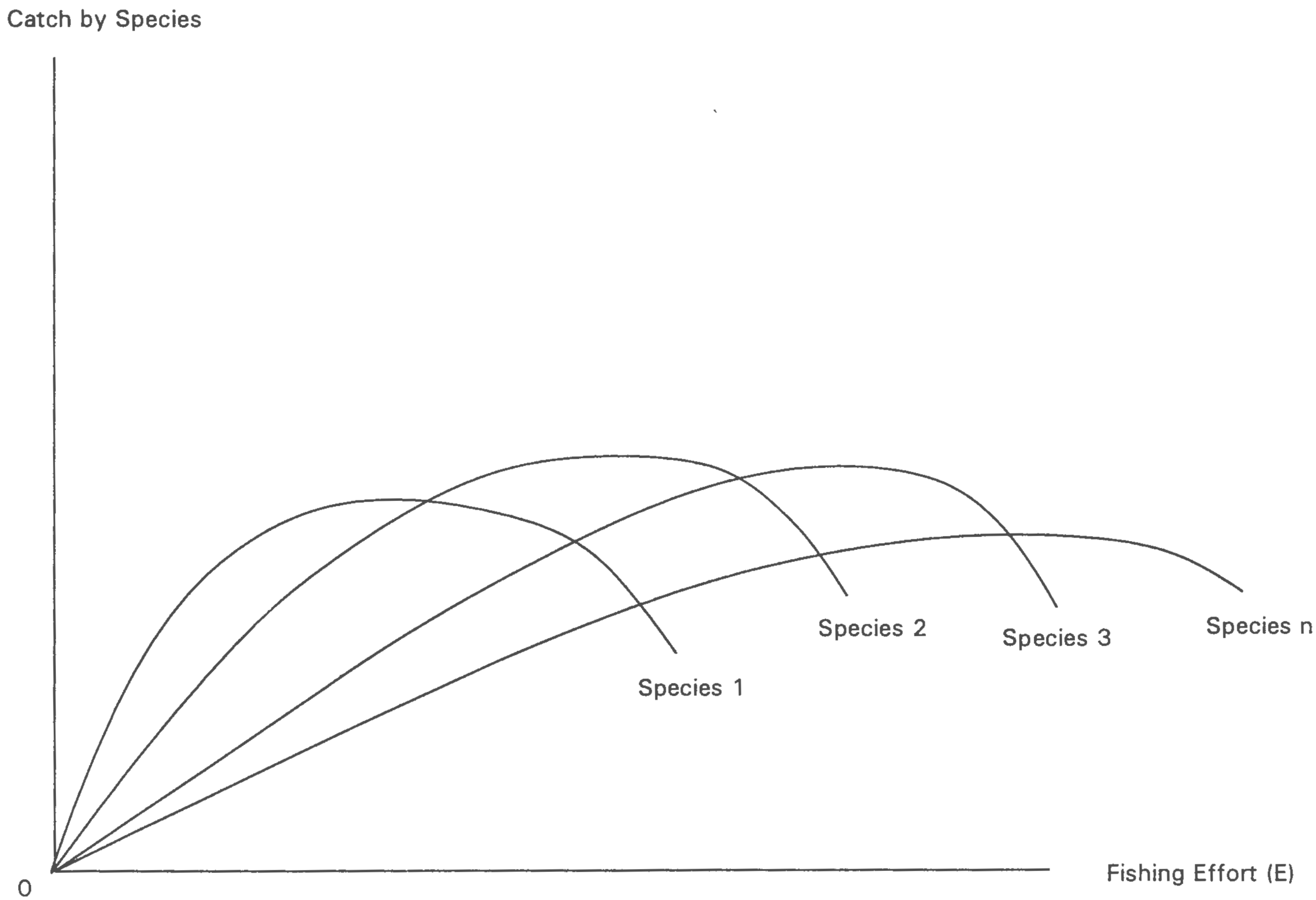
where p_i is the price of species i which is a decreasing function of the level of catch of species i or y_i.

From equation (72), the total TR function for the fisheries is expressed as

$$TR = \sum_{i=1}^{n} p_i(y_i) y_i \tag{73}$$

and the MR and AR functions are expressed as

Figure 12. Catch Curves for a Multiple Species Fishery



$$MR = \sum_{i=1}^{n} mr_i(y_i) \tag{74}$$

and

$$AR = \sum_{i=1}^{n} ar_i(y_i). \tag{75}$$

The TC function, on the other hand, which will be expressed in terms of the total catch, Y (by conversion similar to that applied in the single species and variable price model), is

$$TC = l(Y) \tag{76}$$

and the MC and AC functions are

$$MC = m(Y) \tag{77}$$

and

$$AC = n(Y). \tag{78}$$

Finding the MEY, MSY and OAY again follows procedures the same as those already applied. MEY is the total yield level where the following equation is satisfied

$$MR = MC = \sum_{i=1}^{n} mr_i(y_i) = m(Y). \tag{79}$$

Finally, the MSY and OAY are derived respectively by satisfying the following conditions

$$MR = 0 = \sum_{i=1}^{n} mr_i(y_i) = 0 \tag{80}$$

and

$$AR = AC = \sum_{i=1}^{n} ar_i(y_i) = n(Y). \tag{81}$$

A mathematical or graphical discussion of the multiple species and variable price models is not available in the literature. The review has not encountered an empirical application of the model.

3.5 Other Models

Except from the Gordon-Schaefer and Fox Models, there are also other models which have been developed to analyze overfishing but not covered. In general, these models received little empirical application in developing countries such as the Philippines. Also, some of the models are simple variations of the GS and Fox models.

A model which must be mentioned in this review, however, is the Pella-Tomlison model employed by Trinidad et al. (1993). This model differs from the GS and Fox models in that it provides some adjustment for the skewness in the plotted yield curve. Also, the parameters of the empirical model are estimated not by the usual ordinary least squares procedure but by a search routine.

Trinidad et al. (1993) applied the model using single species and variable prices assumption. However, the model is not reviewed in detail here because of the inavailability of the original work of Pella and Tomlinson (1969) to the reviewers. The interested reader is refered to the Trinidad study for the functional form of the model.

CHAPTER IV

REVIEW OF THE EMPIRICAL LITERATURE ON OVERFISHING

As mentioned, this literature review covers empirical studies dealing only on the economics of overfishing at the national level. There are five such works identified for the Philippines. On the other hand, the review found only a single work on overfishing in another Southeast Asian country.

Numerous studies, however, have already been conducted on the economics of marine fisheries in the Philippines. The interested reader may refer to De Los Angeles et al. (1990) for a listing and review. A few of the studies cited in that work employed bioeconomic analysis. Others analyzed the marketing systems, production costs, revenues and profitability of the fisheries sector. Some evaluated socioeconomic conditions of fishing communities, specifically those of the small-scale municipal fishermen. A few analyzed the impacts of fishery management policies on sectoral performance.

There are also studies in the Philippines which evaluated the overfishing problem in particular areas, such as bays and coastal areas. Because of their limited and localized scope, they are not reviewed here and mentioned only in passing. The examples of these works are those by Pauly and Mines (1982), Silvestre, et al. (1987) and Silvestre et al. (1989).

4.1 Empirical Studies on Overfishing in the Philippines

The empirical economic literature on overfishing in the Philippines may be classified in terms of species coverage. Three of the works are on overfishing of small pelagics. These are Dalzell et al. (1987), Trinidad et al. (1993) and Padilla and De Guzman (1994). One study covered overfishing of demersal species (Silvestre and Pauly 1987). The last study by Schatz (1991) summarized the findings of earlier works and came up with some recommendations for the restructuring of the commercial fisheries industry.

4.1.1 The Dalzell et al. Study

This study evaluated overfishing of small pelagic species by utilizing data for the period 1948-1985 constructed from published statistics of the BFAR. The variables considered by the study in evaluating overfishing were fish catch and fishing effort and the analytical model used was the fox model which assumed a composite small pelagic fish species and fixed fish and effort prices.

The study gathered small pelagic catch data for both marine municipal and commercial fisheries. It defined municipal fisheries as covering vessels less than 3 gross tons in weight and commercial fisheries as covering vessels weighing at least 3 gross tons. The study further identified the particular fish species it covered and ascertained their contributions to the marine fisheries catch based on data for recent years.

To derive annual municipal small pelagic catch, the procedure used by the study was briefly as follows. The data for 1976 onwards were directly had from published sources. For the years prior to 1976 when no data were available, data on catch were extrapolated based on the mean shares of small pelagic catch to total municipal catch in the years 1976 to 1979.

The data on the commercial small pelagic catch used by the study, on the other hand, were taken directly from the published sources as these were available starting 1948. However, since data for years prior to 1965 were considered under-reported, the study scaled them upwards using a scaling factor. Both the municipal and commercial small pelagic catch data used were measured in metric tons.

The study measured fishing effort in terms of horsepower. For the municipal fisheries, the study found that no data on horsepower can be had from the sources, hence, necessitating the estimation of the data. To do this, the data from the past censuses of municipal fishing, conducted in 1948, 1970, 1977 and 1980, on the numbers of powered and non-powered vessels, horsepower of powered vessels and numbers of full-time, part-time and occasional fishermen were had.

After generating the census data, the horsepower of powered vessels were taken directly as the effort data of powered vessels in the municipal fisheries. For the non-powered vessels, the horsepower equivalent of fishermen operating them were computed using a conversion factor. After this was done, the fishermen horsepower was added to the powered vessel horsepower and the sum was adjusted for the proportion of the municipal effort directed towards small pelagics, which was estimated at 38 percent on the total. Lastly, the effort data were adjusted to its purse seine equivalent to fit with the commercial effort data.

For the commercial fisheries, five gears which accounted for a majority of the small pelagic catch were considered. The fleet horsepower data for the years 1978 onwards were generated directly from the published sources. On the other hand, the data for years before 1978 were estimated using computed relationships between horsepower and tonnage and between tonnage and number of vessels for each of the gears. Overall, the study did several adjustments on the effort data. Most notable of this was the incorporation of the effort of the carrier fleet to total effort spent on catching small pelagic species by commercial fishermen.

Based on the constructed 1948-85 data series, the study found that while catch of small pelagics had been increasing in earlier years, generally it had been falling since 1973. In contrast, the effort spent on catching small pelagics had been generally rising. Thus, CPUE had been falling, giving support to the argument that small pelagic species were already overfished.

Using the Fox model, the study computed that the MSY in small pelagics fisheries was at 544,000 metric tons at the fishing effort level of 256,000 horsepower, a level which was already arrived back in 1975. The study further estimated that the MEY was at 500,000 metric tons at the effort level of 155,000 horsepower, a level that was already reached in 1970.

To attain economic efficiency level at MEY in the small pelagic fishery, the study estimated that fishing effort must be reduced to only about 35 percent of the current effort. If this is done, the study computed that a total maximum rent of $250 million at 1985 prices will be derived from the small pelagic fishery.

In conclusion, the study recommended that since small pelagics were overfished, the effort spent catching them must be reduced, at the least down to the MSY level. However, since fishing effort was not equally distributed among fishermen, it also suggested that the reduction can be done selectively, penalizing more the large scale operators, including those employing basing and purse seine gears, and protecting the small scale fishermen.

4.1.2 The Trinidad et al. Study

This study dealt on the bioeconomics of the fishery for small pelagics and explored a mix of issues including biology, production technology and efficiency, costs and profitability and options for management. Its stated objective was to quantify total societal benefits from the small pelagics fishery.

The study used both primary and secondary data. The primary data were collected through a cross-section survey conducted in selected sites in six regions of the country which accounted for a substantial share of small pelagics catch. The sites included the Navotas Fishing Port Complex; Dalahican, Lucena City; Mercedes, Camarines Norte; Banago Wharf, Bacolod City; Guinhalaran, Silay City; Danao City, Cebu; Cawa-Cawa Boulevard, Zamboanga City; and Labuan, Zamboanga. The data collected were for February 1987 up to March 1988. The survey was intended to get information, primarily on the production economics by gear of the small pelagic fishery.

The secondary data used, on the other hand, were time-series taken from the previous study by Dalzell et al (1987) and other published data sources. These data were utilized in an estimation of the yield, cost and revenue curves for small pelagic fishery.

The study profiled the different gears used to catch small pelagics. These gears included surface gillnets, fish corrals, bagnets, drive-in nets, round haul seines under the municipal gear category and trawl, purse seines, encircling gillnets, ringnet and beach seines under the commercial gear category. Details about the operation, fishing season, fishing grounds, species caught and on how the gears were actually operated were provided.

The study estimated the technical efficiency of the gears using three indices, namely, catch per fisher-hour, catch vessel ton per day and catch per adjusted horsepower per day. It found that the most efficient gear was the fish corral in the municipal category and the ringnet in the commercial category. Furthermore, in general, commercial fishing gears were found to be more efficient than municipal gears.

The study also conducted an analysis of capital investment costs, operating costs and profitability related to the gears. Of the commercial gears, the ringnet was found to be most profitable while the purse seine was the most unprofitable. In the municipal category, the drive-in net was found to be the most profitable while the round haul seine was the most unprofitable. Overall, commercial gears were found to be more profitable than municipal gears.

Analyzing further, the study measured the pure profits that the owners of the gears generated from their activities. Results showed that many municipal and commercial fleet owners suffered negative pure profits after deducting the opportunity costs of labor and capital. In the municipal category, the lone gear which exhibited negative pure profits to owners was the round seine. In the commercial category, three gears showed negative pure profits including trawler, purse seine and bagnet. The study concluded that this situation indicated a certain degree of misallocation of resources in the fisheries sector due to the continued employment of losing gears.

Lastly, the study measured resource rents in the small pelagic fishery using a generalized stock production model and exponential cost function fitted on time-series data for the period 1949 up to 1985. The data used by the study on catch and effort levels were taken from Dalzell et al. (1987), the cost per unit horsepower were estimated based on the results of the survey done by the study and the price of fish were taken constant based on the average price of small pelagics for the period 1979-1988.

The results of estimation generally supported the findings of Dalzell, et. al.(1987) that overfishing has already occurred in the small pelagics fishery. The MSY was estimated at 515,000 metric tons per year at the effort level of 320,000 horsepower. The MEY was measured at 465,000 metric tons per year at the effort level of 170,000 horsepower. The open-access effort, on the other hand, was estimated at about 410,000 horsepower which have already occurred in the early 1980s.

In light of the above, the study estimated that to attain the efficiency levels MEY and MSY, the effort spent on small pelagics must be reduced to about 60 percent and 20 percent, respectively, of present levels. To do this, the study recommended a holistic approach to fisheries management, that which considers a mixture of actions. Among these are increased investment in human capital to address population related issues; implementation of macroeconomic policies that does not promote, through effective subsidies, the further expansion of fishing activity; development of alternative non-fisheries based livelihood programs for fisherfolks; creation of a property rights scheme in fisheries that will diminish open access and promote long-term resource conservation; promotion of the backward and forward activities in the fisheries industry; and the development of gear reclassification standards and enforcement of area fishing limits.

4.1.3 The Padilla and De Guzman Study

The main objective of this study was to develop a framework for the environmental resource accounting of the fisheries sector. However, the study did estimations on the sustainable exploitation and economic rent levels also as a basis for its environmental accounting. Empirical application was again on the small pelagic fisheries.

The study utilized time-series data on small pelagics for the period 1948-1991. For the catch data, the study used the same assumptions of Dalzell et al. (1987) to derive the series for 1948-1985. On the other hand, for the later years, the actual data were estimated using measured relationship between the catch and catch per unit effort in earlier years.

For the fishing effort data, the study utilized basically the same procedures used by Dalzell et al. (1987) and, thus, except for some very minor differences also derived the same data series for 1948-1995. For the latter years, effort data were computed using actual unadjusted data employing procedures applied for past years.

The study used the Fox model to come up with a yield curve for small pelagic fisheries. Then, it used an exponential curve to explain the effort function. Results showed that the MSY was at 573,000 metric tons at fishing effort of 294,000 horsepower, the MEY was at 569,000 metric tons at effort of 261,600 horsepower and the OAY was at 457,000 metric tons at effort of 537,900 horsepower. The economic rent if the fishery is operated at MEY is about P7,128 million.

Thus, the findings of the study again did not differ much from that of Dalzell et al.(1987) and Trinidad et al. (1993). The study found likewise that there has been overfishing in small pelagics. This is not surprising given that the studies have used basically similar data sets and exponential models.

In conclusion, the study discussed possible options for the reduction of effort in small pelagic fishery. The pros and cons related to the policy of retiring aging vessels and replacement by technologically advanced ones were discussed. So, were the application of market-based instruments, such as taxation of production inputs. Beyond the discussions, however, the study did not propose any definite measures for reducing fishing effort as its emphasis was on development of a methodology for environmental accounting in fisheries.

4.1.4 The Silvestre and Pauly Study

In contrast to the above three works on small pelagic species, this study covered demersal fish species. The analysis conducted spanned the period 1946-1984 and both the municipal and commercial fisheries. The objective was to investigate if overfishing exists in bottom dwelling species.

The study used catch data for identified demersal species taken from BFAR statistics to get total catch for the years 1952-1984, for both the commercial and municipal fisheries. Then, for the years before 1952, the municipal catch was estimated as a constant fraction of total municipal catch, where the fraction was based on relative catch performance in the years 1976-1979. On the other hand, commercial catch was measured by projecting backward, using the linear trend of the increase of the demersal component of the catch relative to the total commercial catch in the years 1952-1956. The catch data were measured in terms of metric tons.

The method employed for measuring fishing effort for demersal species was as follows. First, since trawl was the major gear used for catching demersal species, its horsepower was taken as measure of fishing effort. The data on trawl horsepower were directly had from Dalzell et al. (1987). Then, from the lifted horsepower data, the final horsepower figures were generated by adjusting horsepower for assumed effects of learning, the doubling of the trawl engine horsepower starting 1958, and the addition of horsepower of carrier vessels in used fishing operations starting 1964.

After deriving time-series catch and effort data for demersal species, the study proceeded to estimate the Fox model. As in the previous works, results were utilized to compute the levels of MSY, MEY and economic rent in the demersal fishery.

The study found that the demersal species have been overfished biologically and economically. The estimated MSY was at a range of 340,000-400,000 metric tons per year while the MEY was at the range of 300,000-325,000 metric tons per year. Both levels were attained way back in the early seventies.

The Study estimated that for MSY and MEY to be attained, the level of effort must be reduced to one-fifth and three-fifths of the 1984 level, respectively. If the MEY is attained, the maximum economic rent that can be generated in quantity terms will amount to about 125,000-200,000 metric tons of fish, worth about P2.0-P3.2 billion per year at 1984 prices.

While the study found strong evidence of overfishing, it evaded from making any recommendations to address it. However, it supported the argument that decreasing fishing effort may serve the interest of the fisheries sector. In closing, it argued that less fishing effort will result to higher incomes for the fishermen and higher public revenues that can be employed on projects that will develop fishing activities in lightly exploited fishing areas and alternative livelihood opportunities in highly exploited fishing areas.

4.1.5 The Schatz Study

This study was basically a review paper and did not conduct any new estimation of overfishing. Its objective was to measure, using secondary information, the economic rent that can be derived from the commercial fisheries and fishpond aquaculture subsectors. Results were intended to provide a basis for rationalizing the license and lease rates imposed on commercial fishermen and public fishponds users.

For the commercial fisheries, the study used mainly results of the studies of Dalzell et al. (1987) and Silvestre and Pauly (1987) to generate estimates of economic rent. It argued that if the level of effort were reduced to half the 1989 level, the estimated economic rent that can be derived will be P15,000 per vessel yearly on the average and P300,000 for the whole commercial fisheries at current prices.

The study admitted that the results of the previous studies on overfishing may be inaccurate. Thus any implementation of a sudden increase in license fees on commercial vessels based on past works may not be appropriate. Therefore, while the study suggested that license fees must be raised, it also proposed that it will be done only on a staggered basis, starting at the level of P1,000 per gross ton of vessels during the first year.

The study made a strong case for raising the license fee rates not only for the specific purpose of reducing effort and in effect conserving fisheries resources but also to generate needed revenues for the government, raise productivity of the commercial fishermen and reduce fishing production costs especially in fuel consumption. It estimated that although jobs will be lost when the license rates move up, this will be more compensated by the above gains.

The study further proposed that for the gradual increasing of the license rates, more accurate and reliable information from new research, specifically on the detailed assessment of fishery stock resources, must be had. In addition, constant monitoring of input and output prices need to be undertaken, to estimate actual annual costs, returns, profits and economic rents incurred and accruing to commercial fishermen.

4.2 Empirical Studies on Overfishing in Southeast Asia

Although only a single study in Southeast Asia was available and reviewed in this work, there may actually be several empirical studies on overfishing undertaken in other developing countries. In Thailand, for instance, fisheries studies, not necessarily on overfishing, already abound. The interested reader may refer to Panayotou and Jetanavanich (1987), the study reviewed below, for a listing and brief review.

4.2.1 The Panayotou and Jetanavanich Study

This study did a comprehensive analysis of the economics and management of the fisheries sector of Thailand and analyzed the degree of overfishing of demersal fisheries species in the Gulf of Thailand.

The study used data on the Gulf of Thailand for the period 1963 to 1982. Catch data were measured in terms of actual fishing yield while effort was standardized fishing effort. The study used the GS model that assumed a composite fish species. Both the fixed price and variable output price assumptions were tried.

Results of estimation indicated that the MSY of the demersal fishery in the Gulf of Thailand ranged from 796,000 to 958,000 tons depending on the mesh size used. This MSY level was attainable at the effort of 15.7 to 20.6 million standard hours, again depending on the mesh size used.

The study concluded that since the current effort at the time the study was conducted exceeded the MSY level of effort, then the demersal fisheries of the Gulf of Thailand was biologically overfished.

The study investigated economic overfishing, by first using the constant price assumption. Again, it generated an MEY effort levels that was lower than prevailing effort level. Moreover, it found that if MEY levels were attained for the Gulf of Thailand demersal fisheries, the profits that can be had ranged from 1,880 to 2,713 million baht depending of mesh size, which represented a big gain from the profits at current levels of exploitation.

When the variable output price assumption was used, the study derived similar results. It again found that MEY effort level was lower than the existing level implying economic overfishing. Also, it found that if fishing were at MEY levels, the profits, consumer surplus and total benefits that can be derived from the fisheries will be even much larger, regardless of mesh size, compared to the case of the fixed price situation.

The study suggested that since both biological and economic overfishing already exists in the Gulf of Thailand, something must be about the problem. To lower intensity of fishing and enhance the fisheries resources in the area, the study suggested a mix of actions that can be implemented. These included an immediate halt to the construction of more trawlers, licensing and control of the activities of the existing vessels, assistance to small large-scale fishermen via fisheries enhancement projects such as development of artificial reefs, community fishing rights, conclusion of new joint ventures and development of alternative sources of animal protein, income and employment.

To recapitulate, from the review of the empirical literature conducted above, it is evident that marine overfishing has been a common conclusion of the past studies in the Philippines and in Thailand. It is observed, however, that all the studies were based mainly on species groupings and not economic sectors. Furthermore, the studies did not investigate the problem of overfishing at the individual fish species level.

CHAPTER V

REGULATORY INSTRUMENTS FOR CONTROLLING OVERFISHING

The general conclusion from the empirical works reviewed in the previous chapter that overfishing already exists in Philippine marine waters brings us to the question of how will overfishing be controlled. In this chapter, the regulatory options available to fishery authorities to contain the problem are reviewed briefly. For more detailed discussion, the interested reader may refer to Crutchfield (1961, 1969); Meany (1987); Buchanan and Tullock (1979); Scott (1979); Huppert (1979); Moloney and Pearse (1979); and Cunningham et al. (1985).

5.1 Regulatory Instruments for Controlling Overfishing

5.1.1 Taxation

Taxation as a fishery regulation for controlling the level of fishing effort can move the fishery from the suboptimal open access level to the economically optimal level via its potential effect on the decision-making of fishermen and not through direct imposition. There are two basic kinds of taxes in fisheries: the tax imposed on catch and the tax imposed on effort.

5.1.1.1 Tax on Catch

There are two ways of administering a tax on catch. It can be imposed across the board, regardless of peculiarities of the catch, or in a varying manner, considering the complications of the catch. For instance, the tax rate can be varied depending on the rate of depletion of a particular fish stock and the impact of the catch on other stocks. The rate could be higher for fish experiencing rapid rate of depletion or significantly affecting the performance of the other stocks.

An example of a tax on catch is a specific levy per kilogram of fish. Theoretically, the levy will be set equal to the maximum resource rent to bring the fishery to the economically desirable level. The imposition of the tax will effectively bring down the price received for the fish by the fishermen, pull down the total revenue curve of the fishermen, force inefficient fishermen out and remaining ones to fish less, and eventually bring catch and effort to the economically optimal levels.

The use of the tax on catch as a means for controlling total fishing effort in the Philippine marine fisheries have some serious disadvantages, however. Firstly, if tax is imposed on the catch of the fishermen, monitoring the catch can be a costly administrative task that may negate gains that can be had with it implementation.

Secondly, if there are no price controls in the fish market, fishermen can easily transfer the burden of the tax to the middlemen and then the middlemen to the consumers, with little income effect on fishermen. In the Philippines, price controls are costly and difficult to administer in the market for fish and for many other consumer items because of a litany of reasons including the large number of informal markets, inadequate staff to monitor, inadequate communication systems and many other problems.

A third problem with the tax on catch is that it is difficult to impose uniformly in the Philippines where many fishing grounds with different productivities exist. Imposing a uniform tax will unfairly penalize local fishermen who cannot move around to search for economically viable fishing grounds and advantage large and well-financed fishermen.

Still another problem with a tax on catch is that it requires up-to-date and reliable price data and information for effective implementation. For instance, sudden and unpredicted changes in the price of fish, a common occurrence in the Philippines, can make the current tax rate impractical and generate strong opposition from the fishermen.

The use of the tax on catch, however, has its advantages when fish catch is easy to monitor, reliable and up-to-date price data are available and fishing has constant productivities across areas. Minus the administrative cost of monitoring, the tax will likely be effective, especially when coupled with some degree of price controls to prevent fishermen and middlemen from transferring the tax burden to others.

5.1.1.2 Tax on Effort

A tax on effort can also be imposed uniformly regardless of the peculiarities of the boat or gear being taxed or in a varying manner depending on the type of boat or gear. Theoretically, the effect of a tax on effort is very similar to the effect of tax on catch.

A tax on effort can be imposed on boats and set equal to the maximum resource rent derived by the boats. The imposition of the tax will bring up the total cost faced by the fishermen, force the inefficient boats out and eventually reduce the total effort to the economically optimal level.

The imposition of a tax on effort has a distinct disadvantage in that there can be several ways to measure effort and coming up with one that is acceptable to the majority can be difficult. This constraint may force the application of a uniform levy on the boats falling under the same classifications, such as in terms of tonnage or horsepower, regardless of differences in actual fishing effort.

Also, a tax on effort which is uniformly applied may in the long-run increase, instead of decrease, total fishing effort. This is because although the inefficient fishermen will leave after the imposition of the tax, the remaining ones will likely fish more to compensate for the loss in earnings due to the tax. As the tax is fixed, fishing more will raise the catch but not the tax, and this may result to a higher fishing effort in the long run.

A third problem with the tax on effort is that even assuming that effort can be defined accurately, the different factors which contribute to total effort will need to be taxed separately for the taxing scheme to be effective. For instance, taxing the labor and horsepower separately and accurately must be done or fishermen will substitute the less taxed factor for the higher taxed one without necessarily reducing fishing effort as a whole.

The above implies that a good and reliable data base by boat, or boat type at the least, will be necessary for taxation by effort to be effective. In the Philippines, this is hardly forthcoming as fishermen appear to change effort components without reporting to authorities, who do not demand such strict reporting themselves.

5.1.1.3 Taxation as a Whole

Taxation, either of catch or of effort, is meant to capture excess profits from fishing and reduce fishing effort as well, and therefore must be considered for management use in the country. In theory, taxation will force fishing units with higher opportunity costs to leave and those with lower opportunity costs to remain in the fishery. This will result to optimal exploitation of fishery resources where government gets the economic rent for distribution to all, the remaining fishermen gets a respectable share of returns and the fishery resources are conserved for future use.

In addition to the above, theoretically, taxation could also be a vehicle for the promotion of social equity in fisheries. When large boats are taxed more and small boats are taxed less, poorer fishermen are effectively protected and their richer counterparts penalized. When the tax revenues are spent on uplifting the lives of poor fishermen, social equity is pursued further. In a country inhabited mostly by poor people, progressive fisheries taxation may be a popular political measure.

In reality, however, taxation is prone to wasteful errors and can attract corruption. As explained, taxation of catch or effort is complicated and, without the benefit of a reliable data base, can turn into a trial and error process. Moreover, administration of taxation in the Philippines fisheries can be badly tainted with corruption, as may taxation be as a whole. Due to these reasons and others already mentioned, the use of taxation may have limited effectiveness as a regulatory instrument.

5.1.2 Licensing

Licensing is similar to taxation in that it is also employed to control fishing effort. However, unlike taxation which allows fishermen to decide for themselves whether or not to remain in the fishery, in a licensing scheme, the fishermen are directly driven out of the fishery by the governing authority.

Basically, licensing is an instrument to directly regulate the number of participants in a fishery It involves the issuance of a permit by the fishery authority for a fisherman, fishing vessel or fishing gear to operate. The goal of the fishery authority in issuing a license is to control fishing effort by controlling the number of permits given away.

Licensing can be operated is different ways. For instance, it can be operated through the "grandfather system" where licenses are given only to existing fishermen and not to newcomers. To decrease fishing effort, licenses are made non-transferable so that existing fishermen who retire from fishing are not replaced by others. As a means of reducing effort fast, the grandfather system is clearly not effective as it may take a long time for fishermen, especially those who treat fishing not only as a livelihood but also as a way of life, to retire.

To address the problem of fishermen longevity, another method can be employed where the licenses are again given to the present fishermen but a buy-back plan is also implemented by the governing authority. In this scheme, less efficient fishermen are allowed to get out of the fishery by buying from them the licenses at a price which is above the value of their discounted net benefits from the fishery. Because of the option to sell at a good price, fishermen are more likely to leave the fishery before their retirement age.

Another licensing method is to have transferable licenses that allow trading of licenses among fishermen. An advantage of this approach is that license holders with high opportunity costs can sell their licenses to those with low opportunity costs. This is expected to lead to an optimal allocation of resources because, eventually, only the fishing units with the lowest opportunity cost are left to hold the license and operate in the fishery.

The transferable licenses, per se, however, may not result to a reduction of total effort in the fishery. In fact, when licenses are transferred to the more efficient fishermen, effort may rise as these people group will raise effort commensurate to the expansion of the right to fish provided for by the traded licenses.

Still another licensing method is to sell the licenses at an auction, whether to existing or would-be fishermen. The number of licenses to be auctioned will have to be limited based on computed total fishing effort that will be needed to efficiently exploit the fishery.

An auction will likely increase the price of the licenses and therefore increase public revenues from the license. It may also effectively reduce the level of fishing effort since the number of licenses to be offered will be limited.

A problem with the auction system, however, is that it causes much of the benefit from fishing to accrue only to the government and the rich fishermen. Thus, poor fishermen may not be inclined to support it. On the other hand, if the revenues from the auction are earmarked for the development of the fishery or of communities of poor fishermen, then fishermen resistance to the scheme may be minimized and the likelihood of success in the implementation of the scheme can be enhanced.

In general, the actual operation of a license has some other associated problems. For instance, whether the fisherman, boat or gear has to be licensed is an issue that needs to be addressed. Ideally, to avoid the possibility of factor substitution that will negate the effort limiting power of a license, a composite effort measure must be derived that covers labor, capital and technology factors. On this composite measure of effort will the imposition of the license be based. The Philippine fisheries sector, however, is still far from developing this ideal measure of effort.

Another problem with the license is that for it not to prevent investment by the fishermen, it must have a duration period that is sufficient for investment to be profitable. On the other hand, the a long-term license can make regulation inflexible. Given the fast changing input and output market conditions that characterize the Philippine fisheries sector, long-term licenses can be impractical and difficult to implement.

Inspite of the abovecited problems, in general, the license is superior to a tax because it entails less administrative costs in implementation. Further, it is likely more effective for reducing effort faster if the number of the licenses allowed are strictly limited. The auction, in particular, has advantages that must be considered, especially if it is implemented properly with strong support from the fishermen.

5.1.3 Individual Fish Quota

An individual fish quota is a way of regulating effort in the fishery by specifying the amount of fish that fishermen can catch. An individual quota can be exclusive or non-transferable and cover an indefinite period. It can also be transferable, marketable and cover a definite duration. When quotas are transferable and sold, they are usually denominated into small units in order to encourage an active market for quotas among the smaller-sized but relatively more numerous fishing units.

A more common way of allocating quotas is the open auction method. In this method, the quotas are sold through a bidding process among fishermen. Whoever bids the highest price for a specific quota holds the right to catch the specified amount of fish. The auction is intended to get the excess profits obtained from the fishery and revert it to the regulating authority. Also, it ensures that the winners to the rights are the most efficient users of the resource.

Another means of allocating the quotas is by basing it on the historical catch criterion. Quotas are awarded to existing fishing units in proportion to their catch during a past qualifying period. This method, however, is difficult to administer with new fishermen who has no fishing records.

Still another means of allocating quotas is by drawing lots among fishing units. This, however, does not guarantee that the most efficient fishing units will get the quota.

In general, fish quotas are either in terms of quantity, such as tons of fish, or as a percentage of the total allowable catch. Quotas, however, can also be specified based on other parameters, depending on the goals of the fishery authority. For instance, if the authority aims to regulate fishing in a certain season, the amount of allowed catch in a quota could be lessened that season. In effect, the quota controls fishing effort within the season concerned.

It can be seen that the fish quota as a regulatory instrument will require reliable data on which to base amount or percentage of the quota. Data on total allowable catch will be needed. In the Philippine fisheries where several species are involved, knowing the total allowable catch as well as the historical catch data of fishermen will be a daunting task.

Another problem with the fish quota is that if applied across all species, it can lead to higher overall effort instead of lower effort. This is because with a quota, fishermen may discriminate against less commercially attractive species in favor of the highly priced species to increase profits. This will lead to the sorting of catch that in the end raises total effective effort as well as wastage of fish catch.

Still another problem with a fish quota is the monitoring and enforcement. With the numerous fishermen, long coastline and broad fishing areas of the Philippines, monitoring the catch of fishermen will entail administrative costs that can be more than the expected benefits from the implementation of the quota.

While many problems can be associated with the possible use of a fish quota in the Philippines, the individual transferable or tradable quota (ITQ) in particular has been shown to be effective in New Zealand (e.g. Panayotou 1995; Pearse 1991). At present, the utilization of this form of quota already has been expanded in that country. While there may be several differences in the fisheries situation in the Philippines compared to that of New Zealand, the quota system must me seriously studied and considered as management alternative for possible application in the fisheries sector in the future.

5.1.4 Overall Quota

An overall fish quota is a limitation on the total volume of fish that can be caught from the fishery. There is no limitation on the number of the fishermen allowed to fish. However, once the quota has been reached, the whole fishery is automatically closed for the remainder of the fishing season.

Outwardly, an overall fish quota seems quite straightforward to apply. For instance, once the level of MSY or MEY is known to the fishery authority, then the quota can be set equal to it and any fishing beyond it is forbidden.

A deeper look at the overall quota, however, shows it has its share of shortcomings. First, output and not effort is limited with the quota. Thus, there is no guarantee that effort will decrease with the quota. This is because when level of fishing is limited to MSY or MEY, profitability of fishing rises. This will encourage fishermen, including the inefficient ones, to compete for the fish allowed for catching. This competition will eventually raise, instead of decrease, fishing effort at least in the short-run.

Second, with more fishermen catching a limited amount of fish, the fishing season will become shorter. It follows that the price of fish will be low only for a short season and then it will rise sharply thereafter. This of course, will not be good for a fish consuming country like the Philippines which requires steady fish supply and prices all year long.

Third, with volumes of fish caught in a short season, there will be the need to put up processing plants to process the fish for future consumption. The possibility of additional investment in processing plants in the Philippines may not be there, however, especially given that fish to be processed will not be available whole year round. Hence, it is likely that a lot of fish will be sold cheaply or wasted during the short fishing season.

Finally, monitoring the total catch of the whole fishery will be a great problem with an overall fish quota. With so many fish outlets and limited communication systems, adding the total fish catch and enforcing a ban thereafter will be an impossible task for the authorities to conduct.

5.1.5 Gear Restrictions

Gear restrictions are another form of limiting effort in the fishery. Either a certain gear is circumscribed in its use or banned outright. Restrictions may not only be on the gear itself but also in terms of limitations on the engine size, boat length, number of hooks per line, net size, dredge size and beam width and other features.

Gear restrictions are generally aimed at lowering the catching efficiency of fishing. Hence, it is likely to be applied more on efficient gears. Also, usually a gear is being restricted because of its ability to destroy sea beds, corals and other fish habitats.

A problem associated with gear restrictions is that fishermen will simply substitute other less efficient, and more costly, gears in place of the restricted efficient gear. This means that fishing effort will not decrease at all while production costs of fishermen are raised. The end result will be lower net returns for fishermen and higher fish prices for consumers.

As a tool for effectively curving acutely destructive fishing, however, gear limitation is a desirable instrument. It is likely be less effective when used as a means to control the total effort in the fishery.

5.1.6 Mesh Size Limitation

Restrictions on the mesh size are intended to limit the size of the fish that can be caught to a certain minimum so that smaller and younger fish will have the time to biologically or economically mature sizes. In general, a rise in the allowed mesh size raises the rate of the survival of smaller fish, the size of caught fish and the MSY and MEY in the fishery.

A problem with increasing mesh size is that by itself it will not reduce effort in the fishery. A rise in the MSY and MEY due to larger mesh sizes will increase the profits and economic rents, encourage more fishermen to enter into the fishery and effectively raise the total fishing effort. The increase in overall effort may erode whatever gains in the fish stock resulting from the mesh size restriction.

Another constraint of the mesh size restriction is that many fishermen catch several species of fish with varying optimum sizes. Any mesh size will still result in the catching of at least some immature fish or the non-catching of some mature fish belonging to certain species. On average, then, the effect of a limit on mesh size may be minimal or uncertain to the growth of the total fish stock.

Still another problem with mesh size limitation is that it is hard to monitor compliance among fishermen. In the Philippines, particularly, mesh size limitation has been known to be ineffective because of lack of forceful enforcement.

For a single-species fishery in a limited fishing area such as a bay, however, mesh size limitations can be effective since the job of monitoring will be easier. Also, it can be potent when used in support of instruments directly limiting effort at the fishery-wide level.

5.1.7 Closed Seasons

A closed season is a period when fishermen are not allowed to fish certain species or at all. It is usually instituted when the quality of the fishery stock is poor, the stock faces irreversible damage or near extinction or when the stock is in spawning season. Generally, a closed season will lead to a better and larger stock at the cost of foregone earnings on the part of fishermen.

A problem with a closed season is that if the stock is always vulnerable to exploitation, the rate of fishing in the next season will be higher resulting in the reduction of the stock back to the pre-closed season level. This may be true with species which are highly priced in the market particularly.

Another problem with a closed season is that it is likely to be economically suboptimal. A closed season is usually implemented at times when the fish stock is most vulnerable to capture. Hence, prohibiting the catching of fish when catching costs are low will counter efficiency concerns.

In the Philippines, even a single closed fishing season for the whole fishery sector will be impossible to implement because of the dependence of a great number of the population on the fisheries sector and the fish eating nature of the entire consuming public. The political opposition to such a move will be great. On the other hand, a closed season for some particular endangered species nearing extinction may be acceptable to the population who are slowly beginning to understand the value of preservation to their welfare.

5.1.8 Closed Areas

A closed area is an area where fishing is not allowed for a part or all of the fishing season. Usually, a closed area restriction is imposed in a known fish nursery area during spawning periods. The intention is to provide the fish stock with space to reproduce without disturbance.

Given the diversity of fish in the sea, the gain from a closed area restriction must be weighed against the loss in catch because of the limitation. The limitation is of course based on the belief that the eventual addition to the stock due to the protection of a fish nursery area will be more than the lost catch from the area.

In the Philippines, closed areas are not only used to protect nursery grounds but also to protect certain endangered species and other resources. It has been known to be successful in many cases. Obviously, however, like closed seasons, it cannot be implemented at a grander scale to reduce effort in the whole fishery sector.

To summarize the overall discussion, this chapter presented the different instruments for the management and regulation of the fishery sector. Each of the regulatory instruments has its share of advantages and disadvantages. In light of the peculiarities of Philippine fisheries, however, it is clear that some have better potential than others. In particular, licensing and gear and mesh size restrictions have already been employed to some extent in the country. Because of the experience gained from their utilization, the continued use of the license scheme, albeit with reforms in the license rates, is an option that the authorities may contemplate. Still another promising option is the use of the ITQ system now being implemented successfully in New Zealand.

CHAPTER VI

REVIEW OF FISHERIES ADMINISTRATION, GOVERNING LAWS AND USE OF REGULATORY INSTRUMENTS IN THE PHILIPPINES

In this chapter, a brief background of the administration of the Philippine fisheries sector, its basic governing laws and its experience in the use of regulatory instruments is presented. The purpose is to generate a picture of the government as fishery administrator, specifically in the area of resource conservation.

6.1 Brief History of Fishery Administration in the Philippines

Very little is known about fishery administration before and during the time of the Spanish occupation. However, in the year 1907, during the American occupation, explicit involvement of the national government in fishery administration commenced when the Fishery Section was established under the Bureau of Government Laboratories. Thereafter, when this bureau was reorganized and renamed the Bureau of Science, the Division of Fisheries was created.

The Division of Fisheries was expanded in 1933 and called the Fish and Game Administration and placed under the Department of Agriculture and Commerce. Then, six years later in 1939, the Division of Fisheries and Zoology was formed under the Bureau of Science.

During the early part of the Japanese occupation, the Bureau of Forestry and Fishery was created to run fishery affairs in the country. Later in the war, the functions of forestry and fishery were separated and a Bureau of Fisheries was established.

After the Japanese occupation, the old pre-war Division of Fisheries was reestablished and then moved to the Department of Agriculture and Commerce, which later was later reorganized into the Department of Agriculture and Natural Resources. In 1963, this bureau was replaced by the Philippine Fisheries Commission, also under the Department of Agriculture and Natural Resources.

In 1974, the Department of Agriculture and Natural Resources was reorganized and split into the Department of Agriculture and Department of Natural Resources. The BFAR, the agency tasked to manage fisheries, was put under the jurisdiction of the latter department. Then, in 1984, control of BFAR and other fisheries related agencies was turned over to the Ministry of Agriculture.

In 1987, the Department of Agriculture was reorganized. The BFAR was placed under the production group of the department, where it remained until the present. With the inclusion of the BFAR into the production group, the fisheries sector has been mainly considered as a source of food, income and employment for the economy. While this has been so, however, it was entrusted responsibility of ensuring the optimum and productive condition of the fisheries and aquatic resources of the country.

To recapitulate, fisheries administration in the Philippines dated back to the time of the American occupation. Over time, the different fishery agencies established have been under different departments. The latest agency, the BFAR, is under the Department of Agriculture. The role of the BFAR is primarily to ensure food sufficiency but its function also includes the maintenance of an optimum and productive condition of fisheries resources.

6.2 Brief History of Fisheries laws in the Philippines

Laws governing the use of coastal and inland water resources in the country dated way back to the year 1866 during the Spanish occupation. The Spanish Law of Waters, adopted in the country on August 3, 1866, formed in those early times the main basis for the authority and supervision of the government over the public waters. This law defined the extent of the national domain to include all the coasts of the maritime frontiers of the Spanish territory, including its shores, natural ponds, lakes, rivers and river beds.

After the Philippine independence from Spain in 1898, the main laws in fisheries consisted of Commonwealth Acts 2657 in 1917 and 2711 in 1934. These laws embodied the regulation of municipal fishing activities by the municipal councils. However, since they focused on municipal fishing, they did not cover the administration of the vast expanse of commercial fishing territory which was part of the national jurisdiction.

Later, the enactment of Republic Act No. 4003 in 1932 paved the way for a comprehensive fisheries administration policy in the country. This act, known as the Fisheries Act of 1932, defined the powers of the national government regarding the administration of fisheries resources. Specifically, it defined the dual authority of the national and municipal governments to regulate the fishery sector.

The Fisheries Act of 1932 was later amended by a series of Commonwealth and Republic Acts. Among the more important features of the amended act was the provision for protection of fisheries resources through the establishment of closed fishing seasons and areas, restrictions on the employment of explosives and poison in fishing, protection of fish eggs and fry, restrictions concerning water pollution, and restrictions on importing fish.

Aside from the Fisheries Act, the Philippine Constitution of 1935 also addressed the fisheries sector. Under Article XII of the constitution, exploitation of the marine resources of the country were exclusively awarded to Filipino citizens and to corporations or associations with at least 60% of capital stock owned by them.

Starting in the 1970s up to the present, the fisheries sector has been governed basically by Presidential Decree No. 704 which was promulgated in 1975. This decree superseded all laws before it. Under it, BFAR was given the sole jurisdiction and responsibility over the management, conservation, development, protection, utilization and disposition of all fishery and aquatic resources of the country except municipal waters which falls under the municipal or city governments.

Finally, Republic Act 7160 or the Local Government Code which was enacted in 1991 significantly affected fisheries as several of its provisions concern specifically on the sector. Among others, the code granted the local governments to enact and enforce laws and measures aimed at conserving and protecting municipal fisheries. In particular, the Provincial Governor is empowered by the code to adopt necessary measures to safeguard and conserve the fishery and other natural resources of the province in coordination with the mayors. This power includes the authority to impose some regulatory instruments, such as closed season or area, whenever the fishery resource is facing the risk of deterioration.

Because of its local emphasis, the code specifies management of fisheries only within local jurisdictions and is generally silent on the management of commercial fisheries. Thus, the role of conserving fishery resources outside of the local jurisdictions remains in the hands of BFAR.

In summary, laws in the Philippines related to the management of the fishery sector have been enacted over the years. The laws have recognized that the public sector must play a part in efforts to conserve fishery resources. In recent years, the responsibility of preserving the local fishery resources fall more and more on the local governments while that of conserving the commercial fishery resources fall on the national government.

6.3 Review on the Use of Regulatory Instruments

Presidential Decree No. 704 and succeeding decrees, letter of instruction and administrative order contained important provisions related to the implementation of regulatory instruments in marine fisheries. The most important of the provisions are the following.

First, Presidential Decree No. 704 specified that any fishery activity in the country should be accompanied by a license, lease or permit, including commercial and municipal marine fishing. It also stipulated that commercial fishing is allowed to operate only in coastal waters 7 fathoms deep or more. Furthermore, the decree disallowed the use destructive fishing techniques and imposed some limitations on trawl fishing.

Second, Presidential Decree No. 704 likewise provides for the preservation of certain fishery areas through the establishment of fish refuges or sanctuaries. In addition, it also stipulates the setting aside of some areas reserved for use by the government or the inhabitants of the municipalities for fish culture, research and scientific purposes.

The stated penalties for violations of the above provisions have been severe. For destructive fishing techniques, a maximum of 12 years for the use of explosives, or 20 years if it results to injuries, or life imprisonment or death sentence if it results to a loss of human life, were imposed. Furthermore, the employment of poisonous substances is punishable by imprisonment for a period of 10 years or up to 12 years if it results to physical injuries or life imprisonment or death sentence if it leads to a loss of life.

The penalties for other violations, however, were light. The penalty for trawl fishing in shallow areas, for instance, is only not more than a fine of P1,000 or imprisonment for one year. Also, an intrusion of a vessel into a reserved or closed fishing area is only subject to a maximum fine of P5,000.

Later, Presidential Decrees Nos. 1015 and 1058 issued in 1976 amended the provision of Presidential Decree No. 704 on licensing of commercial and trawl fishing and penalties on illegal fishing. In general, these two decrees stipulated stiffer limitations and penalties for violations of the imposed regulations than before.

Then, in 1977, Letter of Instruction No. 550 stipulated the training of barangay officials to serve as deputy fish wardens in the enforcement of fishery regulations. This action was designed to strengthen the implementation of the regulations in local areas.

In 1984, under Fisheries Administrative Order No. 144, the annual license fees for commercial fishing were prescribed. The fees that were specified for different boat classifications were as follows:

Boat Classification	Annual License Fee
Non-Powered fishing boat of more than 3 GT	P50.00 + P2.00 per gross ton or fraction thereof
Powered Basnig / Bagnet of more than 3 to 25 GT	P100.00 + P2.00 / gross ton or fraction thereof
Sapiao, kubkub, talakop and / or other fishing gear more than 3 to 25 GT	P100.00 + P2.00 / gross ton and fraction thereof regardless of fishing gear used
For powered vessel used for trawl / towing boats of more than 3 to 25 GT	P125.00 + P2.00 / gross ton and fraction thereof
For powered vessel more than 25 to 50 GT	P150.00 + P2.00 / gross ton and fraction thereof

For motorized boat of more than 50 but not more than 75 GT	P200.00 + P2.00 / gross ton and fraction thereof
For motorized boat of more than 100 GT to 150 GT	P350.00 + P2.00 / gross ton and fraction thereof
For motorized boat of more than 150 to 250 GT	P500.00 + P2.00 / gross ton and fraction thereof
For motorized boat of more than 250 GT	P1,000 + P2.00 / gross ton and fraction thereof

It is obvious from the above that the license fees imposed on the commercial fishery subsector were negligible. At the time of imposition, this was understandable as the low rates were primarily designed neither to raise government revenues nor control fishing effort but to encourage the further development of the commercial fisheries sector.

Finally, a series of administrative orders in the seventies and eighties were promulgated to impose regulatory instruments on specific fishing gears and areas in the country. For some years, closed seasons were imposed on the use of trawls and purse seine in Bohol, Cebu, Negros Oriental, Quezon Province and Palawan. Also, closed seasons were imposed on the use of all kinds of fishing gear in Panguil Bay and on commercial fishing in San Miguel Bay and on ring net within seven kilometers from the shoreline in Camiguin.

To sum up, there is already a history of use of regulatory instruments in the Philippines, especially in recent years. The instruments used include licensing, banning of destructive fishing techniques, area limitations, and closed seasons. The prescribed penalties imposed on violations of the use of destructive fishing methods were severe. On other hand, the license rates imposed on the commercial fisheries were minimal. For purposes of fishery development, the low rates were acceptable. However, clearly, they will not be sufficient for purposes of controlling fishing effort.

CHAPTER VII

PART I: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

In summary, the fisheries sector of the Philippines has been a major food, income, employment, and foreign exchange generating component of the economy. It has been argued, however, that this sector is faced with a serious problem at present. In particular, empirical studies found that marine waters of the country have been overfished.

The available empirical works on overfishing, however have concentrated on grouping of fish species, i.e. small pelagic and demersal species. No work has been done that directly investigates overfishing at the sectoral level, i.e. commercial, municipal and overall marine fisheries. Moreover, the overfishing of individual species has yet to be addressed.

This review first looked into the theory, models and empirical works on overfishing with the purpose of developing an analytical model(s) useful for analyzing overfishing by sector. After This, it discussed the different regulatory instruments to analyze some of the possible instruments for curving overfishing. Finally, it discussed the different fishery institutions, laws and experience in the use of regulatory instruments to see how the public sector has done as a preserver of marine resources.

The review found that the biological and economic theories on overfishing are established theories. The more widely used models for overfishing are the GS and Fox models. These models can be used under different assumptions related to the nature of catch, i.e. single-species or multi-species, and the prices of inputs and output, i.e. variable or fixed. Aside from the two models, there may be several other models for overfishing, however, some of which are variations of the two models mentioned, which are not reviewed here due to time and accessibility constraints.

From the review, it is clear that a GS model or Fox model can be employed to study overfishing at the sectoral level. The main constraints and determinants of the exact type of model that can be applied will depend on availability of time-series catch and effort data as well as data on prices of fish and fishing inputs. Another constraint is the inexact measurement of fishing effort. While the common measure of effort is horsepower in the empirical literature reviewed, there will be the need to improve on this approach, given the importance of other factors of production, e.g. manpower and technology.

The review of regulatory instruments shows that there are many of these which have the potential for controlling fishing effort. The regulatory instruments have common and distinct advantages and disadvantages. Some have potential for implementation nationally while others are likely more effective if used on a site specific basis. There is no single instrument that appear, by itself, to have all the capability to solve overfishing. There were reports, however, that the use of the ITQ system has been successful in New Zealand.

The national government has a long history of administrative involvement in the fisheries sector, dating back to the colonial times. At present, the national government is in charge of the administration of the commercial fisheries while local governments administer the municipal fisheries. In recent years, more and more power have been devolved to the local governments, especially those related to preservation and protection of marine resources in local areas.

The review indicated that over the years, several agencies have been established under different departments to administer the affairs of the sector. At present, the fisheries sector is run by the BFAR, an agency under the Department of Agriculture. Overall, fisheries has been taken by the national government primarily as a food producing component of the economy. The role of government as preserver of fishery resources have been given secondary emphasis.

There have been several laws which formed the main basis for fishery administration in the country. In these laws, provisions for sustainable development and optimal exploitation of resources can be found. Again, however, these functions were secondary to the main function of food production.

The review indicated that the country has experience in the actual use of regulatory instruments. Presently, a major use of a regulatory instrument is the implementation of a license scheme for the commerçial fisheries. The license rates per boat, however, are minimal, due to the standing policy of promoting the development of the fisheries sector. It is obvious, then, that this regulatory instrument did not influence the rate of fishing in the commercial fisheries. Furthermore, the public revenues from the low license fees is clearly a minimal source of funds for the government.

The policy of developing fisheries as a food producing sector of the economy is well placed but must be tempered in light of the destruction of the fisheries resources brought about by too much fishing. In these times, resource conservation must be afforded at least equal importance by the government. In this light, serious thought must be afforded to whether administration of the fisheries shall fall within the domain of the Department of Agriculture or another department specializing work on resource and environmental conservation.

As to the choice of particular approaches that can be used to curve fishing effort in the marine fisheries sector, these will be discussed in more detail in the final recommendations of the study in Part II. At this point, it is obvious from the review that several options can be considered. In the short-run, for instance, since the licensing system has been used for some time already and the authorities have experience in employing it, then its continued use may be prudent. However, the license rates have to be raised to reflect economic rents in fisheries. Furthermore, the number of licenses must be fixed to a maximum, to meet sustainable standards.

Another option that can be explored is the open bidding of the licenses to fishermen. This approach appears desirable because it will ensure that the rights to fish will not go to the first comers but to the efficient fishermen who can compensate the full economic value of the licenses. The open bidding will also discourage any corruption that may result from the allocation of rights to fish.

As mentioned, over the long-term, more innovative ways of managing fishery resources must be discovered. The ITQ system, in particular, is promising in that it has already been shown to work in another country.

Finally, regulatory instruments other than the above can be, and have been, used to curve overfishing, including closed seasons and closed areas in bays and areas that are overexploited or where species are endangered. With the newly mandated involvement of the local governments in natural resource preservation and management, the use of the instruments are advantageous since it entails lower administrative and enforcement costs, especially when administered locally and selectively.

PART II: EMPIRICAL ESTIMATION

CHAPTER VIII

EMPIRICAL MODELS AND THE CONCEPT OF ECONOMIC RENT

8.1 Overall Description and Assumptions of the Models

As shown in Chapter II, there are several models which can be used to evaluate marine resource overfishing. These include those that assume constant or variable fish and fishing effort prices as well as single species or multiple species fisheries. The actual models prominently employed in empirical studies are the GS and Fox Models.

For the empirical analysis of this work, both the GS and Fox models were estimated. However, in the computation of sustainable levels of operation, i.e., MSY, MEY, OAY, only the model with the superior goodness-of-fit was employed. In general, the GS model showed better fit relative to the Fox model. Hence, for purposes of consistency, it was utilized to measure the sustainable levels of operation throughout.

Fixed prices for fish catch and fishing effort were assumed in the estimation. This constraint was forced by the limited reliable time-series information on prices of fish and fishing effort. The alternative approach of estimating the time-series prices of effort based on price indeces and a point in time price value, as done in at least one of the previous studies (Trinidad, et al. 1993), was not done due to its likely inaccuracy given the long period covered by the study. Also, changing the price of fishing effort without varying the price of fish catch, as was done in the past study, is considered an inappropriate way of analysis.

For the analysis of the overall marine fisheries and its two subsectors, commercial and municipal fisheries, the study assumed a single and composite-species fishery. As shown in the review, however, the assumption of composite fish species, has a history of use in empirical works on overfishing.

In the estimation for commercial fisheries, purse seine was highlighted over the other gears because it is the most important gear in that subsector. All the other commercial gears were lumped into a single category "other gears". In the computation, data for "other gears" were computed as the difference between data for the commercial fisheries and data for purse seine. Only the biological models were computed at the gear level. For municipal fisheries and overall marine fisheries, no distinction was made regarding the type of gears used.

For the analysis of the individual fish species, the multiple species assumption was used. Also, only the important species were considered in the analysis. Moreover, the species whose data were unreliable were not covered. Only biological models were estimated for the individual species.

8.2 The Concept of Economic Rent

Aside from the MSY, MEY and OAY, a sustainability indicator that was measured was the economic rent. This indicator has been defined in many ways but a convenient and general explanation can be found in Schatz (1991, p. 3), which calls it the net return that occurs when publicly owned natural resources, such as fisheries, are used in an economically optimal way. This net return is equal to the excess profits which is the difference between the overall economic value of the products produced from the activity less the economic cost of production, where the cost is inclusive of normal profits.

From the above definition, it is clear the economic rent means the excess profits at MEY, which is the economically optimal point. In this study, a minor clarification in the definition of economic rent was made. Here, the term "maximum economic rent" or MER means the excess profits at MEY in the marine fisheries sector. On the other hand, the term "economic rent" or ER means the excess profit at any of the point of operation.

The MER and ER can be expressed mathematically respectively as

$$MER = TR_{\mathbf{mey}} - TC_{\mathbf{mey}} \quad \mathbf{(82)}$$

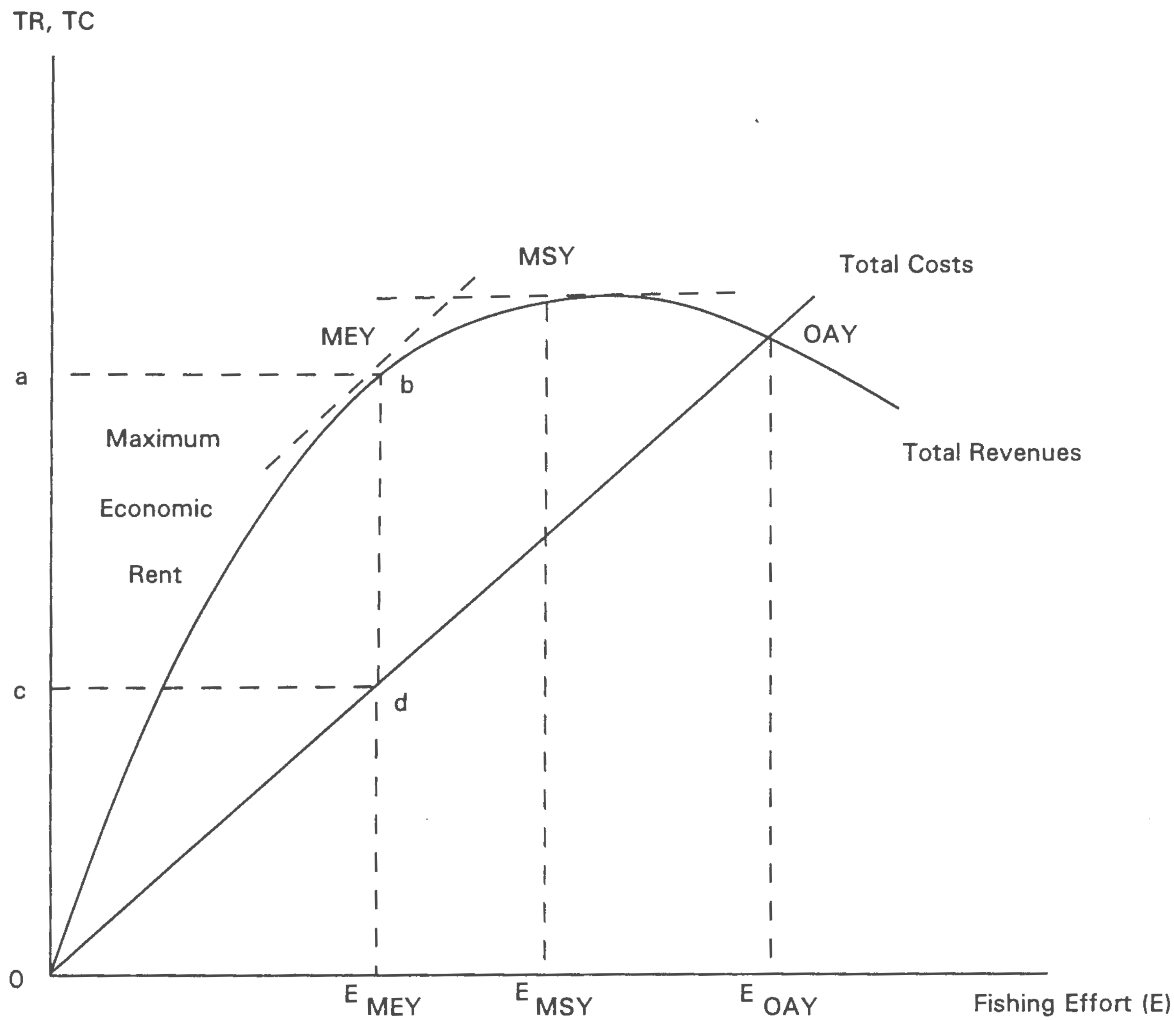
and

$$ER = TR - TC \quad \mathbf{(83)}$$

Redrawing **Figure 8 in Figure 13**, MER is the area represented by abcd. ER, on the other hand, is illustrated by any rectangular area reflecting the difference between the total revenue and total cost curves.

The empirical estimation done will test the hypothesis that overfishing is occurring in the marine fisheries at the considered levels of disaggregation. In terms of results of the estimation of the GS model, this hypothesis will be reflected by the generation of positive and significant intercept and negative but significant coefficient in the estimation of equation (9). In case of the Fox model, this hypothesis will be supported by getting a negative and significant sum of the intercept and coefficient in the estimation of equation (29) or equation (30).

Figure 13. The Gordon-Schaefer Model and Maximum Economic Rent in Marine Fisheries



CHAPTER IX

MARINE FISHERIES DATA FOR EMPIRICAL ANALYSIS

9.1. Data for Commercial Fisheries

9.1.1 Data Sources for Commercial Fisheries

The study used secondary time-series data for the commercial fisheries sector covering the period 1948-1994 only. The sources of data were the BFAR and BAS.

Table 4 describes the published sources of data and the data gathered. The "Fisheries Statistics of the Philippines" of BFAR contains a time-series commercial fisheries by-gear data on fish catch and on gear horsepower, tonnage and number. However, the years when data were available differ for horsepower, tonnage and number.

In 1988, BFAR terminated the collection and publication of fisheries data and this function was taken over by BAS. There have been reports that the quality of fisheries data deteriorated due to this transfer of functions (e.g. Padilla and de Guzman 1994, p. D-4).

The three relevant publications of BAS after 1987 for this work were the "Fishery Statistics", "Commercial Fishery Production Statistics" and "Selected Fishery Statistics". These data sources contain only information on catch but none on horsepower, tonnage and number of gears. Furthermore, for several of the years, only total commercial catch data were available.

9.1.2 Catch in the Commercial Fisheries, 1948-87

The commercial catch data for the period 1948-87 from BFAR are shown in **Table 5.** Dalzell et. al (1987, p.2) noted that data prior to 1965 were under-reported. Hence, a readjustment to take account of this problem was done later in this study.

In 1987, the catch of purse seine was about 40 percent of the total commercial catch, making the gear the most important in the commercial fisheries. The annual growth rates of the catch in the commercial fisheries had been modest during the 1977-87 period indicating that commercial fisheries catch had already stabilized even back in the late 1970s and 1980s.

9.1.3 Engine Horsepower in the Commercial Fisheries, 1948-87

In past studies, fleet or engine horsepower was used as the measure of fishing effort (e.g. Ibid, p.4). Here it was also taken as the measure of fishing effort, but with some modifications.

Table 4. Sources of Data for Commercial Fisheries, 1948-94

Institution	Publication	Years Published	Nature of Catch Data	Nature of Effort Data
BFAR	Fisheries Statistics of the Philippines	1952-87	- Total and by gear data, 1948-87	- Horsepower data, 1978-87 - Tonnage data, 1962-85 - Number data, 1949-87 - All data are total and by gear
BAS	Fishery Statistics	1988-94	- Total and by gear data, 1988 - Total data, 1989-1992 -Total and by gear data, 1993-94	- No data on horsepower, tonnage and number for total and by gear
BAS	Commercial Fishery Production Statistics	1991-94	-Total and by gear data, 1993-94	- No data on horsepower, tonnage and number for total and by gear
BAS	Selected Fishery Statistics	1990-94	- Total and by gear data, 1988 - Total data, 1989-1992 -Total and by gear data, 1993-94	- No data on horsepower, tonnage and number for total and by gear

Table 5. Catch in the Philippine Commercial Fisheries, 1948-87 (Metric Tons)

Year	Purse Seine	Other Gears	All Gears
1948	915	41,081	41,996
1949	949	53,878	54,827
1950	236	47,697	47,933
1951	188	68,839	69,027
1952	580	72,735	73,315
1953	348	72,540	72,888
1954	623	102,597	103,220
1955	775	106,435	107,210
1956	766	105,893	106,659
1957	562	93,386	93,948
1958	606	111,271	111,877
1959	406	117,412	117,818
1960	586	119,436	120,022
1961	873	124,753	125,626
1962	953	149,083	150,036
1963	3,748	205,000	208,748
1964	9,569	248,531	258,100
1965	28,675	271,399	300,074
1966	25,701	289,198	314,899
1967	40,445	290,477	330,922
1968	63,168	343,626	406,794
1969	80,050	288,677	368,727
1970	86,718	295,159	381,877
1971	117,694	264,582	382,276
1972	148,454	276,300	424,754
1973	232,587	232,835	465,422
1974	204,940	265,735	470,675
1975	168,215	330,402	498,617
1976	211,417	296,780	508,197
1977	190,607	327,558	518,165
1978	137,058	368,782	505,840
1979	174,029	326,718	500,747
1980	163,153	325,325	488,478
1981	168,918	325,850	494,768
1982	198,179	328,094	526,273
1983	212,979	306,337	519,316
1984	193,054	320,281	513,335
1985	183,414	328,573	511,987
1986	224,730	321,500	546,230
1987	239,663	351,529	591,192
Ave. Annual Growth Rate (1977-87)	0.036	0.009	0.014

Source of Data. BFAR (Various Years). "Philippine Fisheries Statistics".

As shown in **Table 4**, BFAR did not gather information on the engine horsepower for the entire 1948-87 period but instead, in the earlier years, gathered only data on the tonnage and/or number of gears. Due to the inconsistency, the engine horsepower data series was constructed based on the raw data on horsepower, tonnage and number of fishing vessels from BFAR.

The actual procedure used here to construct engine horsepower was similar to those applied in previous works. First, for 1978-1987, the horsepower data were available from the source, but not on actual horsepower but only in ranges. In particular, the data were expressed in number of fishing vessels and gear type falling within horsepower ranges. The ranges were: less than 50 horsepower, 50 - 124 horsepower, 125-199 horsepower, 200 - 300 horsepower, and more than 300 horsepower.

To derive the horsepower series for the period 1978-1987, the midpoints of the middle ranges were multiplied by the corresponding number of the vessels falling within the ranges. For the outlying ranges, the numbers 50 and 300 were multiplied by the number of the vessels falling within the said ranges.

Next, for the period 1962-1977, only the number of vessels and gross tonnage data were available. To generate a series, a linear regression, with zero intercept, was used to estimate relationship between gross tonnage and horsepower using the data for 1978-1987. The derived relationship were then used to estimate horsepower data for 1962-1977.

For the period 1948-1961, only data on the number of fishing vessels were available. Thus, linear regression was again used to estimate the relationship between the gross tonnage and number of vessels using 1962-1987 data. The derived relationship was used to estimate the gross tonnage for 1948-1961. Then, horsepower data for the period 1948-1961 were measured using the earlier derived relationship between gross tonnage and horsepower for period 1978-1987.

The resulting engine horsepower data series for purse seine, other gears and all gears are shown in **Table 6.** There has been a rapid rise in the total engine horsepower in commercial fisheries. The total horsepower in 1987 was more than twelve times the total horsepower in 1948.

9.1.4 Catch in the Commercial Fisheries, 1988-94

The BAS generated commercial fisheries catch data for period 1988-94 are shown in **Table 7.** The average annual growth rates of the catch were much higher than those for 1977-87 based on BFAR data **(see Table 5).** This inconsistency occurred likely because with the change in the agencies generating the data, the procedures and methods used for the data gathering also changed. Consequently, this led to the overestimation of the commercial fisheries catch after 1988. This overestimation was also noted by Padilla and de Guzman (1994).

Because of this problem, there was the need to readjust the data for the 1988-94 period so that the trend in the exploitation of fishery resources during the years before it was maintained. To

Table 6. Engine Horsepower in the Philippine Commercial Fisheries, 1948-87

Year	Purse Seine	Other Gears	All Gears
1948	1,697	58,507	60,204
1949	1,885	102,123	104,008
1950	3,106	139,626	142,732
1951	4,902	203,171	208,073
1952	6,599	252,520	259,119
1953	5,467	247,396	252,863
1954	9,238	282,478	291,716
1955	7,164	282,123	289,287
1956	14,328	269,151	283,479
1957	12,254	255,040	267,294
1958	10,746	330,365	341,111
1959	14,517	348,820	363,337
1960	14,894	348,254	363,148
1961	14,140	358,984	373,124
1962	1,586	396,285	397,871
1963	1,867	455,047	456,914
1964	8,057	439,204	447,261
1965	9,459	517,078	526,537
1966	17,795	607,147	624,942
1967	18,668	582,457	601,125
1968	22,073	555,171	577,244
1969	23,839	564,322	588,161
1970	23,776	590,309	614,085
1971	27,906	508,508	536,414
1972	51,974	529,790	581,764
1973	107,887	605,137	713,024
1974	45,789	526,246	572,035
1975	46,444	486,685	533,129
1976	51,341	490,058	541,399
1977	48,712	391,371	440,083
1978	62,754	415,872	478,626
1979	80,564	511,310	591,874
1980	81,808	520,377	602,185
1981	98,587	578,497	677,084
1982	111,083	630,483	741,566
1983	95,186	691,183	786,369
1984	81,560	641,219	722,779
1985	80,202	654,749	734,951
1986	73,177	618,606	691,783
1987	76,442	680,218	756,660

Source of Basic Data. BFAR (Various Years). "Philippine Fisheries Statistics".

Table 7. Catch in the Philippine Commercial Fisheries, 1988-94 (Metric Tons)

Year	Purse Seine (a)	Other Gears	All Gears
1988	263,439	336,556	599,995
1989	289,918	347,220	637,138
1990	319,058	381,506	700,564
1991	351,128	408,687	759,815
1992	386,421	418,445	804,866
1993	425261	420,170	845,431
1994	400246	485,200	885,446
Ave. Annual Growth Rate (1988-94)	0.074	0.064	0.067

Source of Data: BAS (Various Years). "Fishery Statistics".

(a) Purse seine catch figures for 1989-92 were estimated.

do this, there were two options contemplated. First was to simply manipulate the catch for 1988-94, e.g. by using the average annual catch growth rate of the 1977-87 period with the 1987 catch as base figure. Second was to maintain the catch figures for 1988-94 from BAS and instead manipulate the effort figures for said period.

Using the first option meant throwing away the BAS catch data altogether. To prevent this from occurring, the second option was applied. This is explained below.

9.1.5 Engine Horsepower in the Commercial Fisheries, 1988-94

As already cited, no data on which a measurement of the engine horsepower can be based were available after 1987. To address this problem, an initial approach taken was to gather painstakingly the unpublished horsepower data from BFAR files. The generated data set, however, was inconsistent at best (For instance, the derived horsepower figures did not match gains in catch reported after 1988 by BAS). Because of this, a decision was made not to use the data set.

It then became necessary to extrapolate the engine horsepower data for the 1988-94 period. The procedure actually followed in doing this took account of the overestimated catch data after 1987. First, for total commercial fisheries and for purse seine and other gears, annual catch to horsepower ratios from 1977-87 were computed based on the figures in **Table 5.** Second, the average annual growth rates of the ratios were determined. Third, the catch to horsepower ratios for 1988-94 were estimated based on the average annual rate of growth of the ratios. Fourth, the annual engine horsepower for 1988-94 were computed by dividing the yearly catch by corresponding horsepower ratios for the period.

The generated engine horsepowers for the 1988-94 period are provided in **Table 8**. It is obvious that similar to the catch data, the figures were overestimated. However, these horsepower figures ensure that even with the overestimated catch, the growth of the catch to horsepower ratio, which was an essential element in the analysis of overfishing, was consistently maintained for the whole period.

9.1.6 Labor Horsepower in the Commercial Fisheries, 1948-94

The fishing effort in commercial fisheries involves not only the engine input but the labor input as well. In past studies on overfishing, the labor input in commercial fisheries was ignored. In this study, the inclusion of labor input as component of fishing effort was made.

Trinidad et al. (1993) estimated, based on a survey conducted in 1988, that the average crew of purse seiners were 67 people and that for commercial fisheries as a whole were 24 people **(Table 9).** When translated to engine horsepower employing the ratio of Karim (1985), these inputs of labor amount to 12.06 horsepower for purse seiners and 4.32 horsepower for commercial fisheries, respectively.

Table 8. Estimated Engine Horsepower in the Philippine Commercial Fisheries, 1988-94 (a)

Year	Purse Seine	Other Gears	All Gears
1988	83,918	712,786	796,704
1989	92,235	785,493	877,728
1990	101,376	899,894	1,001,270
1991	111,423	1,015,225	1,126,648
1992	122,466	1,115,706	1,238,172
1993	134,603	1,214,710	1,349,313
1994	126,523	1,339,611	1,466,134

(a) To estimate, the average growth rate in the catch/horsepower ratios from 1977-87 was computed. This rate was then used to estimate catch/horsepower ratios for 1988-94. Lastly, the catch for 1988-94 in Table 4 were divided by the estimated catch/horsepower ratios to generate the horsepower values for 1988-94.

Table 9. Computation of Ratio of Labor Horsepower to Engine Horsepower in the Philippine Commercial Fisheries

Gear	Average Crew/Boat	Conversion to Hp (a)	Average Hp/Boat	Labor Hp/ Engine Hp
Purse Seine	67	12.06	383	0.032
Commercial	24	4.32	160	0.027

Source of Basic Data: Trinidad et al. (1993) and Karim (1985). Data were for 1988.
(a) Karim (1985) estimated the average daily output of a Southeast Asian male is equivalent to .18 engine horsepower.

On the other hand, in 1988, the average engine horsepower of purse seiners was 388 while that of the whole commercial fisheries was 160. Therefore, the labor to engine horsepower ratio for purse seiners was .032 and that for commercial fisheries was .027.

There were no available data that indicated any change in the ratio of labor to engine horsepower over time. Hence, these ratios were taken as constant over time to get the horsepower equivalent of the labor input. The total labor and engine horsepower for the period 1948-94 in the commercial fisheries sector are provided in **Table 10.** With the constant ratios, as in the case of the engine horsepower alone, engine plus labor horsepower has been increasing rapidly over the years also.

9.1.7 Learning Effects Adjusted Horsepower in the Commercial Fisheries, 1948-94

In addition to engine and labor horsepower, engine and labor learning factors were taken as important components of the fishing effort in commercial fisheries. This was because improvements in the gears employed in the commercial fisheries were likely to have positive impacts on effective fishing effort. For instance, bigger and newer boats fish longer days. Furthermore, a more experienced crew likely works more hours on actual fishing than on other non-fishing related boat activities.

Learning has not been considered as part of fishing effort in most previous studies on overfishing. This was probably due to the difficulty encountered in actually measuring learning effects for the fisheries sector. Silvestre et al. (1986), however, generated learning factors for the trawl fisheries which was later used by Silvestre and Pauly (1987). These learning factors were provided in **Table 11.**

In the absence of any other available measure for learning impacts in fishing, this study assumed that learning factors for trawl fishing apply for the commercial fisheries sector as a whole and for other gears (this was another unavoidable constraint of the study). Furthermore, it was assumed that learning factors equally apply for all the gears and crew. **Table 12** provides the learning effects adjusted total engine and labor horsepower in commercial fisheries.

9.1.8 Carrier Fleet Horsepower in the Commercial Fisheries, 1948-94

The commercial carrier fleet are an important component of the commercial fisheries and must be imputed into the computation of total fishing effort also. Carriers are in use in the transport of purse seine catch as well as of other major commercial gear catch to minimize travel time from the fishing areas to the fish ports. The importance of the carrier fleets as part of commercial fishing effort was also recognized by Dalzell et al. (1987).

There were few available data on the commercial carrier fleet from the BFAR and BAS publications. Therefore, to estimate carrier engine horsepower, data for 1964 to 1985 were directly lifted from Dalzell et al. (1987). Following said study, it was assumed that the level of carrier fleet

Table 10. Engine and Labor Horsepower in the Philippine Commercial Fisheries, 1948-94 (a)

Year	Purse Seine	Other Gears	All Gears
1948	1,751	60,078	61,830
1949	1,945	104,871	106,816
1950	3,205	143,380	146,586
1951	5,059	208,632	213,691
1952	6,810	259,305	266,115
1953	5,642	254,048	259,690
1954	9,534	290,059	299,592
1955	7,393	289,705	297,098
1956	14,786	276,346	291,133
1957	12,646	261,865	274,511
1958	11,090	339,231	350,321
1959	14,982	358,166	373,147
1960	15,371	357,582	372,953
1961	14,592	368,606	383,198
1962	1,637	406,977	408,614
1963	1,927	467,324	469,251
1964	8,315	451,022	459,337
1965	9,762	530,992	540,753
1966	18,364	623,451	641,815
1967	19,265	598,090	617,355
1968	22,779	570,050	592,830
1969	24,602	579,439	604,041
1970	24,537	606,128	630,665
1971	28,799	522,098	550,897
1972	53,637	543,834	597,472
1973	111,339	620,936	732,276
1974	47,254	540,226	587,480
1975	47,930	499,593	547,523
1976	52,984	503,033	556,017
1977	50,271	401,694	451,965
1978	64,762	426,787	491,549
1979	83,142	524,713	607,855
1980	84,426	534,018	618,444
1981	101,742	593,623	695,365
1982	114,638	646,951	761,588
1983	98,232	709,369	807,601
1984	84,170	658,124	742,294
1985	82,768	672,026	754,795
1986	75,519	634,942	710,461
1987	78,888	698,202	777,090
1988	86,603	731,611	818,215
1989	95,186	806,240	901,426
1990	104,620	923,684	1,028,304
1991	114,988	1,042,079	1,157,067
1992	126,384	1,145,218	1,271,603
1993	138,910	1,246,834	1,385,744
1994	130,572	1,375,147	1,505,719

(a) Estimated based on the labor horsepower to engine horsepower ratio in Table 9.

Table 11. Learning Factors in the Philippine Commercial Fisheries, 1948-94 (a)

Year	Learning Factor	Year	Learning Factor
1948	2.55	1972	1.25
1949	2.55	1973	1.20
1950	2.55	1974	1.16
1951	2.55	1975	1.11
1952	2.55	1976	1.07
1953	2.55	1977	1.04
1954	2.55	1978	1.00
1955	2.55	1979	1.00
1956	2.55	1980	1.00
1957	2.55	1981	1.00
1958	2.55	1982	1.00
1959	2.55	1983	1.00
1960	2.55	1984	1.00
1961	2.35	1985	1.00
1962	2.18	1986	1.00
1963	2.03	1987	1.00
1964	1.90	1988	1.00
1965	1.78	1989	1.00
1966	1.68	1990	1.00
1967	1.59	1991	1.00
1968	1.51	1992	1.00
1969	1.44	1993	1.00
1970	1.37	1994	1.00
1971	1.31		

Source of Data: Table 8 of Silvestre et al. (1986).

(a) The source provided learning factors up to 1981. Factors for 1982-94 were estimated to be the same as those for 1978-81.

Table 12. Learning Effects Adjusted Horsepower in the Philippine Commercial Fisheries, 1948-94 (a)

Year	Purse Seine	Other Gears	All Gears
1948	687	23,560	24,247
1949	763	41,126	41,889
1950	1,257	56,228	57,485
1951	1,984	81,817	83,800
1952	2,671	101,688	104,359
1953	2,213	99,627	101,839
1954	3,739	113,749	117,487
1955	2,899	113,610	116,509
1956	5,799	108,371	114,170
1957	4,959	102,692	107,651
1958	4,349	133,032	137,381
1959	5,875	140,457	146,332
1960	6,028	140,228	146,256
1961	6,210	156,854	163,063
1962	751	186,687	187,437
1963	949	230,209	231,158
1964	4,376	237,380	241,756
1965	5,484	298,310	303,794
1966	10,931	371,102	382,033
1967	12,117	376,157	388,274
1968	15,086	377,517	392,602
1969	17,085	402,389	419,473
1970	17,910	442,430	460,340
1971	21,984	398,548	420,532
1972	42,910	435,068	477,977
1973	92,783	517,447	610,230
1974	40,736	465,712	506,448
1975	43,180	450,084	493,264
1976	49,518	470,124	519,642
1977	48,337	386,245	434,582
1978	64,762	426,787	491,549
1979	83,142	524,713	607,855
1980	84,426	534,018	618,444
1981	101,742	593,623	695,365
1982	114,638	646,951	761,588
1983	98,232	709,369	807,601
1984	84,170	658,124	742,294
1985	82,768	672,026	754,795
1986	75,519	634,942	710,461
1987	78,888	698,202	777,090
1988	86,603	731,611	818,215
1989	95,186	806,240	901,426
1990	104,620	923,684	1,028,304
1991	114,988	1,042,079	1,157,067
1992	126,384	1,145,218	1,271,603
1993	138,910	1,246,834	1,385,744
1994	130,572	1,375,147	1,505,719

(a) Computed based on the learning factors in Table 11.

was insignificant prior to 1964. Then, the figures for carrier engine horsepower for 1986-94 were measured simply by applying on the data the average annual growth rate of total engine horsepower for the period 1988-94.

The data for the carrier engine horsepower, carrier labor horsepower and total commercial fisheries carrier horsepower for 1948-94 are provided in **Table 13.** The figures for labor horsepower were generated by using the constant ratio of engine to labor horsepower derived earlier in **Table 9.**

The total carrier engine and labor horsepower in **Table 13** were then adjusted for learning effects based on the learning factors provided in **Table 11**. The resulting figures are shown in **Table 14.** The figures for purse seine were estimated based on the computed annual ratios of purse seine catch to total catch **(see Tables 5 and 7).**

9.1.9 Total Learning Adjusted Horsepower in the Commercial Fisheries, 1948-94

Table 15 shows total horsepower in the commercial fisheries, inclusive of engine and labor inputs and adjusted for learning effects, for 1948-94. These figures represent the fishing effort in the commercial fisheries used by the study.

9.1.10 Standardization of Fishing Effort Based on Purse Seine Efficiency

In contrast to previous studies (e.g. Dalzell et al. 1987), no standardization of the fishing effort of other gears based on purse seine efficiency was done in this study. The main reason for this is that standardization will lead to effort values for other gears which are different from actual values. Since actual effort is the one priced and paid for in the market, standardization will likely bias economic analysis by overpricing or underpricing total effort of other gears and of commercial fisheries as a whole.

9.1.11 Adjusted Catch, Effort and Catch/Effort in the Commercial Fisheries, 1948-94

In **Table 16,** the total fish catch data from **Tables 5 and 7** and the total fishing effort figures from **Table 15** for the commercial fisheries are presented together. It was beforehand mentioned that fish catch data before 1965 were underestimated. To address this, a final adjustment of the catch data was done.

To scale up the fish catch data before 1965, the following procedure was applied. First, CPUE for the period 1965-94 were computed **(Table 16).** Then, CPUE as the dependent variable was regressed against effort as independent variable using the exponential form (This form gave a better fit relative to the linear form). The results of regression are given in **Table 17.** Using the figures in **Table 17,** the estimated CPUE for the years 1948-64 were generated and multiplied by the corresponding effort to derive the adjusted yearly fish catch data for the period. The adjusted fish catch, fishing effort and CPUE are given in **Table 18.**

Table 13. Carrier Engine and Labor Horsepower in Philippine Commercial Fisheries, 1948-94

Year	Engine Hp (a)	Labor Hp (b)	Total Hp
1948	0	0	0
1949	0	0	0
1950	0	0	0
1951	0	0	0
1952	0	0	0
1953	0	0	0
1954	0	0	0
1955	0	0	0
1956	0	0	0
1957	0	0	0
1958	0	0	0
1959	0	0	0
1960	0	0	0
1961	0	0	0
1962	0	0	0
1963	0	0	0
1964	6,005	162	6,167
1965	11,167	302	11,469
1966	16,325	441	16,766
1967	52,516	1,418	53,934
1968	24,771	669	25,440
1969	28,165	760	28,925
1970	32,383	874	33,257
1971	51,546	1,392	52,938
1972	92,523	2,498	95,021
1973	28,261	763	29,024
1974	128,955	3,482	132,437
1975	116,990	3,159	120,149
1976	119,111	3,216	122,327
1977	116,291	3,140	119,431
1978	84,133	2,272	86,405
1979	101,485	2,740	104,225
1980	153,200	4,136	157,336
1981	199,571	5,388	204,959
1982	214,337	5,787	220,124
1983	241,717	6,526	248,243
1984	221,504	5,981	227,485
1985	242,062	6,536	248,598
1986	266,268	7,189	273,457
1987	292,895	7,908	300,803
1988	322,185	8,699	330,884
1989	354,403	9,569	363,972
1990	389,843	10,526	400,369
1991	428,828	11,578	440,406
1992	471,710	12,736	484,447
1993	518,881	14,010	532,891
1994	570,770	15,411	586,180

(a) Data on carrier horsepower were lifted from Dalzell et al. Data for 1986 to 1994 were estimated based on average annual growth rate of total engine horsepower of .10 percent from 1988-94.
(b) Ratio of labor horsepower to engine horsepower was average for commercial fisheries at 1:.027.

Table 14. Learning Adjusted Carrier Horsepower in the Philippine Commercial Fisheries, 1948-94 (a)

Year	Purse Seine (b)	Other Gears	All Gears (b)
1948	0	0	0
1949	0	0	0
1950	0	0	0
1951	0	0	0
1952	0	0	0
1953	0	0	0
1954	0	0	0
1955	0	0	0
1956	0	0	0
1957	0	0	0
1958	0	0	0
1959	0	0	0
1960	0	0	0
1961	0	0	0
1962	0	0	0
1963	0	0	0
1964	120	3,126	3,246
1965	616	5,827	6,443
1966	815	9,165	9,980
1967	4,146	29,775	33,921
1968	2,616	14,231	16,848
1969	4,361	15,726	20,087
1970	5,513	18,763	24,275
1971	12,441	27,969	40,410
1972	26,568	49,449	76,017
1973	12,087	12,100	24,187
1974	49,711	64,458	114,170
1975	36,517	71,725	108,242
1976	47,560	66,764	114,324
1977	42,243	72,594	114,837
1978	23,411	62,993	86,405
1979	36,222	68,003	104,225
1980	52,551	104,786	157,336
1981	69,975	134,985	204,959
1982	82,892	137,232	220,124
1983	101,808	146,435	248,243
1984	85,552	141,933	227,485
1985	89,058	159,540	248,598
1986	112,506	160,952	273,457
1987	121,942	178,861	300,803
1988	145,281	185,603	330,884
1989	165,619	198,353	363,972
1990	182,340	218,029	400,369
1991	203,522	236,884	440,406
1992	232,586	251,861	484,447
1993	268,050	264,841	532,891
1994	264,970	321,211	586,180

(a) Learning factors in Table 11 were used.

(b) Data for purse seine is computed based on the ratio of purse seine catch to total catch.

Table 15. Learning Adjusted Total Horsepower in the Philippine Commercial Fisheries, 1948-94

Year	Purse Seine	Other Gears	All Gears
1948	687	23,560	24,247
1949	763	41,126	41,889
1950	1,257	56,228	57,485
1951	1,984	81,817	83,800
1952	2,671	101,688	104,359
1953	2,213	99,627	101,839
1954	3,739	113,749	117,487
1955	2,899	113,610	116,509
1956	5,799	108,371	114,170
1957	4,959	102,692	107,651
1958	4,349	133,032	137,381
1959	5,875	140,457	146,332
1960	6,028	140,228	146,256
1961	6,210	156,854	163,063
1962	751	186,687	187,437
1963	949	230,209	231,158
1964	4,497	240,506	245,002
1965	6,100	304,137	310,237
1966	11,746	380,267	392,013
1967	16,262	405,932	422,195
1968	17,702	391,748	409,450
1969	21,445	418,115	439,560
1970	23,423	461,192	484,615
1971	34,425	426,517	460,943
1972	69,478	484,516	553,994
1973	104,870	529,547	634,416
1974	90,448	530,170	620,618
1975	79,697	521,809	601,506
1976	97,078	536,888	633,966
1977	90,580	458,839	549,419
1978	88,174	489,780	577,953
1979	119,364	592,715	712,080
1980	136,977	638,804	775,780
1981	171,717	728,608	900,325
1982	197,530	784,182	981,712
1983	200,040	855,804	1,055,844
1984	169,722	800,057	969,779
1985	171,826	831,566	1,003,392
1986	188,025	795,894	983,919
1987	200,831	877,062	1,077,893
1988	231,884	917,214	1,149,098
1989	260,805	1,004,593	1,265,398
1990	286,960	1,141,713	1,428,673
1991	318,510	1,278,963	1,597,473
1992	358,970	1,397,079	1,756,049
1993	406,960	1,511,675	1,918,635
1994	395,541	1,696,358	2,091,899

Table 16. Unadjusted Catch, Effort and Catch/Effort in the Philippine Commercial Fisheries, 1948-94

Year	Catch (Mt)	Effort (Hp)(a)	Catch/Effort
1948	41,996	24,247	1.7320
1949	54,827	41,889	1.3089
1950	47,933	57,485	0.8338
1951	69,027	83,800	0.8237
1952	73,315	104,359	0.7025
1953	72,888	101,839	0.7157
1954	103,220	117,487	0.8786
1955	107,210	116,509	0.9202
1956	106,659	114,170	0.9342
1957	93,948	107,651	0.8727
1958	111,877	137,381	0.8144
1959	117,818	146,332	0.8051
1960	120,022	146,256	0.8206
1961	125,626	163,063	0.7704
1962	150,036	187,437	0.8005
1963	208,748	231,158	0.9031
1964	258,100	245,002	1.0535
1965	300,074	310,237	0.9672
1966	314,899	392,013	0.8033
1967	330,922	422,195	0.7838
1968	406,794	409,450	0.9935
1969	368,727	439,560	0.8389
1970	381,877	484,615	0.7880
1971	382,276	460,943	0.8293
1972	424,754	553,994	0.7667
1973	465,422	634,416	0.7336
1974	470,675	620,618	0.7584
1975	498,617	601,506	0.8289
1976	508,197	633,966	0.8016
1977	518,165	549,419	0.9431
1978	505,840	577,953	0.8752
1979	500,747	712,080	0.7032
1980	488,478	775,780	0.6297
1981	494,768	900,325	0.5495
1982	526,273	981,712	0.5361
1983	519,316	1,055,844	0.4918
1984	513,335	969,779	0.5293
1985	511,987	1,003,392	0.5103
1986	546,230	983,919	0.5552
1987	591,192	1,077,893	0.5485
1988	599,995	1,149,098	0.5221
1989	637,138	1,265,398	0.5035
1990	700,564	1,428,673	0.4904
1991	759,815	1,597,473	0.4756
1992	804,866	1,756,049	0.4583
1993	845,431	1,918,635	0.4406
1994	885,446	2,091,899	0.4233

(a) Effort is the sum of the fishing gear and carrier horsepowers.

Table 17. Regression Results for Catch/Effort and Effort in the Philippine Commercial Fisheries, 1965-94

Specification	a	log (a)	b	Adjusted R2
Catch/Effort = a effort exp(b)	488.217	6.19*	-.488*	.89
or		(14.61)	(-15.65)	
Log(Catch/Effort) = log (a) + b log (Effort)				

Figures in parenthesis are t-values. * means significant at the 1 percent level.

Table 18. Final Catch, Effort and Catch/Effort in the Philippine Commercial Fisheries, 1948-94

Year	Catch (Mt)	Effort (Hp)	Catch/Effort
1948	85,653	24,247	3.5325
1949	113,310	41,889	2.7050
1950	133,235	57,485	2.3177
1951	161,584	83,800	1.9282
1952	180,787	104,359	1.7324
1953	178,539	101,839	1.7531
1954	192,090	117,487	1.6350
1955	191,270	116,509	1.6417
1956	189,295	114,170	1.6580
1957	183,684	107,651	1.7063
1958	208,102	137,381	1.5148
1959	214,935	146,332	1.4688
1960	214,877	146,256	1.4692
1961	227,180	163,063	1.3932
1962	243,969	187,437	1.3016
1963	271,604	231,158	1.1750
1964	279,811	245,002	1.1421
1965	300,074	310,237	0.9672
1966	314,899	392,013	0.8033
1967	330,922	422,195	0.7838
1968	406,794	409,450	0.9935
1969	368,727	439,560	0.8389
1970	381,877	484,615	0.7880
1971	382,276	460,943	0.8293
1972	424,754	553,994	0.7667
1973	465,422	634,416	0.7336
1974	470,675	620,618	0.7584
1975	498,617	601,506	0.8289
1976	508,197	633,966	0.8016
1977	518,165	549,419	0.9431
1978	505,840	577,953	0.8752
1979	500,747	712,080	0.7032
1980	488,478	775,780	0.6297
1981	494,768	900,325	0.5495
1982	526,273	981,712	0.5361
1983	519,316	1,055,844	0.4918
1984	513,335	969,779	0.5293
1985	511,987	1,003,392	0.5103
1986	546,230	983,919	0.5552
1987	591,192	1,077,893	0.5485
1988	599,995	1,149,098	0.5221
1989	637,138	1,265,398	0.5035
1990	700,564	1,428,673	0.4904
1991	759,815	1,597,473	0.4756
1992	804,866	1,756,049	0.4583
1993	845,431	1,918,635	0.4406
1994	885,446	2,091,899	0.4233

9.1.12 Adjusted Catch, Effort and Catch/Effort for Purse Seine and Other Commercial Gears, 1948-94

Following the same approach, the unadjusted catch, effort and catch per unit effort for purse seine and other gears were gathered **(Table 19).** Then, the catch prior to 1965 were adjusted employing the same approach applied above.

For purse seine, CPUE as dependent variable was regressed against effort as independent variable using the exponential form **(Table 20).** Then, the estimated CPUE for 1948-64 were had and multiplied by effort to get the adjusted fish catch data for said years. The adjusted fish catch, fishing effort and CPUE are shown in given in **Table 21.** The catch and effort data for other gears were simply measured as the difference between the catch and effort for total gears and purse seine.

9.1.13 Prices of Fish Catch and Cost of Fishing Effort in the Commercial Fisheries, 1994

As cited earlier, the price of fish and the cost of fishing effort were assumed constant in the analysis for reasons already mentioned. The price of commercial fish per metric ton for 1994 was generated by averaging the market wholesale prices for major commercial fish species **(Table 22).**

On the other hand, the cost of effort was estimated by taking the average of the price of effort for purse seine, trawl, bagnet and ringnet generated by the survey undertaken by Trinidad et al. (1993) in 1988. The average figure was scaled upward, to 1994, by employing the average inflation rate in the Philippines (The use of the average inflation rate, compared to other input specific price indeces, was deemed superior because of the diversity of the actual inputs comprising fishing effort). The computation of the cost of fishing effort are given in **Tables 23.**

9.2 Data for Municipal Fisheries

9.2.1 Data Sources for Municipal Fisheries

This study use secondary time-series data for the municipal fisheries covering the period 1948-1994. The sources were BFAR, BAS and Dalzell et al. (1987).

Table 24 shows that "Fisheries Statistics of the Philippines" only has municipal catch data for 1976-87 and no effort data. On the other hand, "Fishery Statistics" has data for later years but has no data on effort. Dalzell et al. has data on municipal small pelagic catch for the period 1948-85 from which the total municipal catch data can be estimated. It also has data on horsepower for the municipal fisheries for the same period.

9.2.2 Catch in the Municipal Fisheries, 1948-94

The catch data series for the municipal fisheries sector for the period 1948-94 is shown in **Table 25.** The data for 1948-75 were estimated from Dalzell et al. based on the assumption that

Table 19. Unadjusted Catch, Effort and Catch/Effort of Purse Seine and Other Gears, 1948-87 (Metric Tons)

Year	Purse Seine Catch	Purse Seine Effort	Purse Seine Catch/Effort	Other Gears Catch	Other Gears Effort	Other Gears Catch/Effort
1948	915	687	1.3323	41,081	23,560	1.7437
1949	949	763	1.2440	53,878	41,126	1.3101
1950	236	1,257	0.1877	47,697	56,228	0.8483
1951	188	1,984	0.0948	68,839	81,817	0.8414
1952	580	2,671	0.2172	72,735	101,688	0.7153
1953	348	2,213	0.1573	72,540	99,627	0.7281
1954	623	3,739	0.1666	102,597	113,749	0.9020
1955	775	2,899	0.2673	106,435	113,610	0.9368
1956	766	5,799	0.1321	105,893	108,371	0.9771
1957	562	4,959	0.1133	93,386	102,692	0.9094
1958	606	4,349	0.1393	111,271	133,032	0.8364
1959	406	5,875	0.0691	117,412	140,457	0.8359
1960	586	6,028	0.0972	119,436	140,228	0.8517
1961	873	6,210	0.1406	124,753	156,854	0.7953
1962	953	751	1.2693	149,083	186,687	0.7986
1963	3,748	949	3.9489	205,000	230,209	0.8905
1964	9,569	4,497	2.1281	248,531	240,506	1.0334
1965	28,675	6,100	4.7010	271,399	304,137	0.8924
1966	25,701	11,746	2.1881	289,198	380,267	0.7605
1967	40,445	16,262	2.4870	290,477	405,932	0.7156
1968	63,168	17,702	3.5685	343,626	391,748	0.8772
1969	80,050	21,445	3.7327	288,677	418,115	0.6904
1970	86,718	23,423	3.7023	295,159	461,192	0.6400
1971	117,694	34,425	3.4188	264,582	426,517	0.6203
1972	148,454	69,478	2.1367	276,300	484,516	0.5703
1973	232,587	104,870	2.2179	232,835	529,547	0.4397
1974	204,940	90,448	2.2658	265,735	530,170	0.5012
1975	168,215	79,697	2.1107	330,402	521,809	0.6332
1976	211,417	97,078	2.1778	296,780	536,888	0.5528
1977	190,607	90,580	2.1043	327,558	458,839	0.7139
1978	137,058	88,174	1.5544	368,782	489,780	0.7530
1979	174,029	119,364	1.4580	326,718	592,715	0.5512
1980	163,153	136,977	1.1911	325,325	638,804	0.5093
1981	168,918	171,717	0.9837	325,850	728,608	0.4472
1982	198,179	197,530	1.0033	328,094	784,182	0.4184
1983	212,979	200,040	1.0647	306,337	855,804	0.3580
1984	193,054	169,722	1.1375	320,281	800,057	0.4003
1985	183,414	171,826	1.0674	328,573	831,566	0.3951
1986	224,730	188,025	1.1952	321,500	795,894	0.4039
1987	239,663	200,831	1.1934	351,529	877,062	0.4008
1988	263,439	231,884	1.1361	336,556	917,214	0.3669
1989	289,918	260,805	1.1116	347,220	1,004,593	0.3456
1990	319,058	286,960	1.1119	381,506	1,141,713	0.3342
1991	351,128	318,510	1.1024	408,687	1,278,963	0.3195
1992	386,421	358,970	1.0765	418,445	1,397,079	0.2995
1993	425261	406,960	1.0450	420,170	1,511,675	0.2779
1994	400246	395,541	1.0119	485,200	1,696,358	0.2860

Table 20. Regression Results for Catch/Effort and Effort for Purse Seine, 1965-94

Specification	a	log (a)	b	Adjusted R2
Catch/Effort = a effort exp(b) or Log(Catch/Effort) = log (a) + b log (Effort)	144.46	4.9730* (12.267)	-.3887* (-11.071)	.81

Figures in parenthesis are t-values. * means significant at the 1 percent level.

Table 21. Final Catch, Effort and Catch/Effort of Purse Seine and Other Gears, 1948-87 (Metric Tons)

Year	Purse Seine Catch	Purse Seine Effort	Purse Seine Catch/Effort	Other Gears Catch	Other Gears Effort	Other Gears Catch/Effort
1948	7,832	687	11.4045	77,821	23,560	3.3031
1949	8,352	763	10.9481	104,958	41,126	2.5521
1950	11,334	1,257	9.0164	121,901	56,228	2.1680
1951	14,980	1,984	7.5510	146,604	81,817	1.7919
1952	17,965	2,671	6.7270	162,822	101,688	1.6012
1953	16,013	2,213	7.2375	162,526	99,627	1.6313
1954	22,067	3,739	5.9025	170,023	113,749	1.4947
1955	18,891	2,899	6.5156	172,379	113,610	1.5173
1956	28,858	5,799	4.9767	160,437	108,371	1.4804
1957	26,227	4,959	5.2886	157,457	102,692	1.5333
1958	24,204	4,349	5.5655	183,898	133,032	1.3824
1959	29,090	5,875	4.9514	185,845	140,457	1.3231
1960	29,550	6,028	4.9023	185,327	140,228	1.3216
1961	30,092	6,210	4.8460	197,088	156,854	1.2565
1962	8,271	751	11.0162	235,698	186,687	1.2625
1963	9,545	949	10.0568	262,059	230,209	1.1384
1964	24,703	4,497	5.4938	255,108	240,506	1.0607
1965	28,675	6,100	4.7010	271,399	304,137	0.8924
1966	25,701	11,746	2.1881	289,198	380,267	0.7605
1967	40,445	16,262	2.4870	290,477	405,932	0.7156
1968	63,168	17,702	3.5685	343,626	391,748	0.8772
1969	80,050	21,445	3.7327	288,677	418,115	0.6904
1970	86,718	23,423	3.7023	295,159	461,192	0.6400
1971	117,694	34,425	3.4188	264,582	426,517	0.6203
1972	148,454	69,478	2.1367	276,300	484,516	0.5703
1973	232,587	104,870	2.2179	232,835	529,547	0.4397
1974	204,940	90,448	2.2658	265,735	530,170	0.5012
1975	168,215	79,697	2.1107	330,402	521,809	0.6332
1976	211,417	97,078	2.1778	296,780	536,888	0.5528
1977	190,607	90,580	2.1043	327,558	458,839	0.7139
1978	137,058	88,174	1.5544	368,782	489,780	0.7530
1979	174,029	119,364	1.4580	326,718	592,715	0.5512
1980	163,153	136,977	1.1911	325,325	638,804	0.5093
1981	168,918	171,717	0.9837	325,850	728,608	0.4472
1982	198,179	197,530	1.0033	328,094	784,182	0.4184
1983	212,979	200,040	1.0647	306,337	855,804	0.3580
1984	193,054	169,722	1.1375	320,281	800,057	0.4003
1985	183,414	171,826	1.0674	328,573	831,566	0.3951
1986	224,730	188,025	1.1952	321,500	795,894	0.4039
1987	239,663	200,831	1.1934	351,529	877,062	0.4008
1988	263,439	231,884	1.1361	336,556	917,214	0.3669
1989	289,918	260,805	1.1116	347,220	1,004,593	0.3456
1990	319,058	286,960	1.1119	381,506	1,141,713	0.3342
1991	351,128	318,510	1.1024	408,687	1,278,963	0.3195
1992	386,421	358,970	1.0765	418,445	1,397,079	0.2995
1993	425261	406,960	1.0450	420,170	1,511,675	0.2779
1994	400246	395,541	1.0119	485,200	1,696,358	0.2860

Table 22. Average Market Wholesale Prices of Commercial Fish Species, 1994

Species	Price/Mt. (Pesos)
Tuna	31,100
Galunggong	29,050
Dilis	22,560
Tamban	16,630
Sapsap	30,710
Bisugo	49,010
Alumahan	42,300
Bangus	56,050
Dalagang Bukid	54,070
Espada	32,900
Lapulapu	76,130
Talakitok	69,320
Big Shrimp	181,270
Small Shrimp	91,040
Kalaso	24,140
Average	49,742

Source: BAS (1994). "Fishery Statistics"

Table 23. Estimated Cost of Fishing Effort, 1988-94

Year	Ave. Inflation Rate (a) (Percent)	Cost of Effort (b) (Pesos)
1988	8.9	8,258
1989	12.2	9,265
1990	14.2	10,581
1991	18.7	12,560
1992	8.9	13,678
1993	7.6	14,718
1994	9.0	16,043

(a) From the National Statistics Office.

(b) 1988 figure was derived from Trinidad (Personal Communications) based on a 1988 survey. The figure was average for purse seine, trawl, bagnet and ringnet. 1989-94 figures were computed based on the annual inflation rates.

Table 24. Sources of Data for Municipal Fisheries, 1948-94

Institution	Publication	Years Published	Nature of Catch Data	Nature of Effort Data
BFAR	Fisheries Statistics of the Philippines	1952-87	- Total data, 1976-87	- No data
BAS	Fishery Statistics	1988-94	- Total data, 1988-94	- No data
ICLARM	Dalzell et al.	1987	- No total data - Small pelagic data, 1948-85	- data on total horsepower, 1948-85

Table 25. Catch, Effort and Catch/Effort in the Philippine Municipal Fisheries, 1948-94

Year	Catch(a) (Mt)	Effort(b) (Hp)	Catch/ Effort(c)
1948	130,052	45,258	2.87
1949	158,669	54,899	2.89
1950	146,793	61,197	2.40
1951	197,393	68,220	2.89
1952	208,706	76,053	2.74
1953	199,266	84,789	2.35
1954	205,371	94,534	2.17
1955	218,983	105,403	2.08
1956	248,509	117,528	2.11
1957	253,808	131,051	1.94
1958	257,166	146,139	1.76
1959	260,573	162,969	1.60
1960	264,481	181,748	1.46
1961	268,448	202,689	1.32
1962	272,475	226,055	1.21
1963	276,562	252,124	1.10
1964	282,726	281,208	1.01
1965	303,930	313,657	0.97
1966	326,725	349,862	0.93
1967	351,229	390,256	0.90
1968	444,179	435,326	1.02
1969	477,492	485,614	0.98
1970	510,546	768,673	0.66
1971	542,904	604,336	0.90
1972	598,733	674,199	0.89
1973	639,795	752,154	0.85
1974	684,498	839,143	0.82
1975	731,725	936,211	0.78
1976	619,145	1,044,531	0.59
1977	712,514	936,115	0.76
1978	775,932	1,300,017	0.60
1979	635,543	1,450,905	0.44
1980	647,284	1,559,870	0.41
1981	709,989	1,806,252	0.39
1982	708,016	2,015,449	0.35
1983	770,988	2,248,911	0.34
1984	789,975	2,509,457	0.31
1985	785,132	2,800,208	0.28
1986	807,275	3,152,262	0.26
1987	816,247	3,489,601	0.23
1988	838,346	3,924,015	0.21
1989	882,369	4,521,795	0.20
1990	895,040	5,021,765	0.18
1991	913,524	5,611,605	0.16
1992	854,687	5,748,142	0.15
1993	803,194	5,914,174	0.14
1994	786,847	6,343,329	0.12

(a) Data for 1948-75 were extrapolated from Dalzell et al. (1987) based on the estimate that small pelagic catch was 38 percent of municipal catch. Data for rest of the years came from published BFAR and BAS sources.

(b) Data for 1948-85 came from Dalzell et al. (1987). Those for later years were extrapolated by dividing the catch data by the catch/effort data for each year.

(c) Data for 1986-94 were extrapolated by first getting the average annual growth rate of catch/effort for period 1975-85. This rate was then applied to get catch/effort for succeeding years.

catch in small pelagics comprised 38 percent of total municipal catch. The catch data for the latter years were simply lifted from the BFAR and BAS publications.

9.2.3 Adjustment in the Municipal Fisheries Catch Data

Unlike in the commercial fisheries, there was no report of an underestimation of the municipal catch prior to 1965. Also, there was no sign of overestimation of the BAS data for 1988 and beyond as these appeared consistent with those for previous years. Hence the study also did not adjust for underestimation or overestimation of catch data.

9.2.4 Effort in the Municipal Fisheries, 1948-94

Table 25 also shows the fishing effort in municipal fisheries, measured in terms of horsepower. The data for 1948-85 were lifted directly from Dalzell et al. and were the total of engine and labor horsepower. The figures for 1988-94 were estimated by getting the average annual growth rate of catch per unit effort for 1975-85 and then using this rate and the catch figures for the latter years to extrapolate both the catch per unit effort and effort.

9.2.5 Adjustment in the Municipal Fishing Effort Data

The effort data from Dalzell et al. already includes both the engine and labor horsepower and, hence, a further adjustment along this line was no longer necessary. There were no data indicating learning effects over time in municipal fishing and this prevented an adjustment related to learning. Lastly, the municipal fishermen in general use their catcher boats to also haul the catch to shore. Thus, no adjustment related to the use of carrier boats was needed.

9.2.6 Prices of Fish Catch and Cost of Fishing Effort in the Municipal Fisheries, 1994

The price of fish from municipal waters per metric ton for 1994 was generated by averaging the market wholesale prices of the more popular municipal fish species **(Table 26).**

There is no available data that can be used to estimate the cost of effort in the municipal fisheries. In this work, it was simply assumed that this cost was one-half that of the commercial fisheries.

9.3 Data for Total Marine Fisheries

9.3.1 Data for Total Marine Fisheries Catch and Effort, 1948-94

The data for the total marine fisheries for catch and effort were simply the summation of the catch and effort for commercial and municipal fisheries. The figures are shown in **Table 27.**

Table 26. Average Market Wholesale Price of Popular Municipal Fish Species, 1994

Species	Price/Mt. (Pesos)
Galunggong	29,050
Dilis	22,560
Tamban	16,630
Sapsap	30,710
Alumahan	42,300
Average	28,250

Source: BAS (1994). "Fishery Statistics".

Table 27. Catch, Effort and Catch/Effort in the Philippine Marine Fisheries, 1948-94

Year	Catch (Mt)	Effort (Hp)	Catch/Effort
1948	215,705	69,505	3.1034
1949	271,979	96,788	2.8101
1950	280,028	118,682	2.3595
1951	358,977	152,020	2.3614
1952	389,493	180,412	2.1589
1953	377,805	186,628	2.0244
1954	397,461	212,021	1.8746
1955	410,253	221,912	1.8487
1956	437,804	231,698	1.8895
1957	437,492	238,702	1.8328
1958	465,268	283,520	1.6410
1959	475,508	309,301	1.5374
1960	479,358	328,004	1.4614
1961	495,628	365,752	1.3551
1962	516,444	413,492	1.2490
1963	548,166	483,282	1.1343
1964	562,537	526,210	1.0690
1965	604,004	623,894	0.9681
1966	641,624	741,875	0.8649
1967	682,151	812,451	0.8396
1968	850,973	844,776	1.0073
1969	846,219	925,174	0.9147
1970	892,423	1,253,288	0.7121
1971	925,180	1,065,279	0.8685
1972	1,023,487	1,228,193	0.8333
1973	1,105,217	1,386,570	0.7971
1974	1,155,173	1,459,761	0.7913
1975	1,230,342	1,537,717	0.8001
1976	1,127,342	1,678,497	0.6716
1977	1,230,679	1,485,534	0.8284
1978	1,281,772	1,877,970	0.6825
1979	1,136,290	2,162,985	0.5253
1980	1,135,762	2,335,650	0.4863
1981	1,204,757	2,706,577	0.4451
1982	1,234,289	2,997,161	0.4118
1983	1,290,304	3,304,755	0.3904
1984	1,303,310	3,479,236	0.3746
1985	1,297,119	3,803,600	0.3410
1986	1,353,505	4,136,181	0.3272
1987	1,407,439	4,567,494	0.3081
1988	1,438,341	5,073,114	0.2835
1989	1,519,507	5,787,193	0.2626
1990	1,595,604	6,450,438	0.2474
1991	1,673,339	7,209,079	0.2321
1992	1,659,553	7,504,191	0.2212
1993	1,648,625	7,832,810	0.2105
1994	1,672,293	8,435,228	0.1983

9.3.2 Data for the Marine Fisheries Catch, by Species, 1976-87

For the analysis on overfishing of individual species, catch data for the top 35 species caught in the marine fisheries were gathered **(Table 28).** These include Acetes, Anchovies, Barracuda, Big-Eyed Scad, Caesio, Cavalla, Crab, Crevalle, Croaker, Eastern Little Tuna, Flying Fish, Frigate Tuna, Garfish, goatfish, Grouper, Hairtail, Herring, Indian Mackerel, Indo-Pacific Mackerel, Lizard Fish, Mullet, Porgies, Prawn, Round Scad, Sardine, Shrimp, Siganid, Skipjack, Slipmouth, Snapper, Spanish Mackerel, Squid, Treadfin Breams, White Shrimp and Yellowfin Tuna.

The reliable time-series data on marine fisheries catch by the species covers the period 1976-87 only. The source of data was the "Fisheries Statistics of the Philippines" of the BFAR. The data on species catch for latter years coming from BAS were not utilized because of possible overestimation. Also, adjustment of the BAS catch data by species, as conducted for total commercial fisheries, cannot be done since data on fishing effort by species were not available.

9.3.3 Prices of Fish Catch and Cost of Fishing Effort in the Marine Fisheries, 1994

The price of the fish from all marine waters per metric ton for 1994 was generated by averaging the market wholesale prices of the commercial and municipal fisheries **(Table 29).**

There was no available data useful for measuring the cost of effort in the whole marine fisheries sector. Thus, it was assumed that this amount is three-fourths that of the commercial fisheries.

Table 28. Catch of Specific Species in the Philippine Marine Fisheries, 1976-87

Year	Acetes	Anchovies	Barracuda	Big-eyed Sca	Butterfly	Caesio	Cavalla	Crab
1976	7,230	55,305	3,111	30,101	320	9,836	12,380	8,293
1977	6,284	36,217	4,604	33,232	131	6,397	20,117	7,697
1978	6,521	44,873	4,525	26,902	323	8,112	12,643	8,243
1979	5,409	47,983	3,041	29,545	315	6,501	12,621	13,424
1980	8,945	60,409	2,772	30,089	36	10,228	12,811	8,946
1981	19,360	53,522	5,033	19,621	160	8,684	14,803	12,878
1982	25,686	47,777	4,415	15,710	142	9,878	23,596	9,752
1983	9,924	65,995	5,398	14,765	127	9,604	12,353	23,622
1984	7,554	63,387	4,403	20,717	144	6,950	19,044	13,553
1985	17,455	70,781	5,861	20,390	119	6,669	19,239	12,289
1986	16,614	68,978	8,156	20,092	149	6,008	17,574	14,026
1987	14,335	66,935	7,370	21,054	229	5,796	17,105	11,731

Year	Crevalle	Croaker	Eastern Little Tuna	Eels	Flatfish	Flying Fish	Frigate Mackerel	Garfish
1976	5,779	9,336	18,906	483	367	10,919	22,227	3,456
1977	9,962	2,865	40 455	2931	1,071	14,702	31,689	6,022
1978	6,761	2,551	26,873	1026	1,034	11,889	30,002	4,567
1979	9,615	2,644	15,825	381	1,155	10,929	40,215	6,435
1980	6,510	2,492	14,772	551	912	16,647	43,564	4,524
1981	7,116	4,097	17,820	596	770	31,035	31,107	8,412
1982	7,171	4,060	32,082	761	2,207	21,530	27,501	7,637
1983	12,262	4,076	36,421	855	1,049	14,444	40,122	10,965
1984	10,794	7,200	23,067	1123	1,060	24,323	32,945	12,198
1985	11,071	7,723	22,387	1058	1,127	20,610	42,240	13,354
1986	9,853	9,325	22,097	1337	700	17,013	43,029	9,115
1987	10,902	7,010	24,321	1683	1,541	17,784	40,362	9,188

Table 28. Catch of Specific Species in the Philippine Marine Fisheries, 1976-87 (Continued)

Year	Gizzard Sha	Goatfish	Herring	Indian Mackerel	Indo-Pacific Mackerel	Grouper	Milkfish	Mullet
1976	543	3,671	37,216	10,729	17,036	14,463	2,317	4,626
1977	552	8,051	43,505	19,469	13,692	17,364	358	5,285
1978	264	5,968	21,086	22,144	10,938	12,371	411	7,552
1979	264	7,750	8,499	24,735	7,614	15,655	982	7,823
1980	372	6,488	17,513	11,639	12,745	15,234	163	6,865
1981	150	8,042	18,328	13,992	9,051	18,637	195	6,052
1982	606	7,188	13,663	10,802	10,933	15,990	77	7,662
1983	629	8,566	12,745	14,411	13,803	16,423	599	6,194
1984	760	16,417	23,118	15,817	15,898	23,014	580	12,166
1985	913	18,398	18,078	18,599	14,016	23,547	176	10,667
1986	880	14,556	18,349	18,151	13,871	27,408	704	12,098
1987	619	17,639	18,495	18,779	12,661	23,937	701	13,617

Year	Prawns	Round Scad	Sardine	Shark	Shrimp	Siganids	Skipjack	Slipmouth
1976	275	39,666	43,098	4,883	20,307	5,164	19,358	30,837
1977	448	26,067	96,673	4,604	10,455	7,738	32,571	21,236
1978	1,160	27,583	102,700	3,876	9,281	8,358	34,914	22,014
1979	1,295	31,338	68,931	3,608	9,992	10,905	25,258	23,952
1980	1,064	20,813	79,446	3,702	9,757	7,196	18,692	20,895
1981	2,125	29,090	86,771	7,545	11,784	9,715	20,733	21,925
1982	1,712	32,987	92,517	5,593	11,693	19,257	19,612	23,048
1983	2,802	33,762	92,377	4,661	10,905	13,461	17,538	28,218
1984	1,547	26,570	70,467	5,817	9,425	15,899	15,800	36,269
1985	1,578	25,446	49,580	5,490	10,878	16,010	18,103	35,154
1986	1,469	24,557	45,031	9,386	14,770	12,752	25,253	37,580
1987	2,176	30,352	55,628	5,709	10,253	12,077	26,060	40,317

Table 28. Catch of Specific Species in the Philippine Marine Fisheries, 1976-87 (Continued)

Year	Snapper	Spanish Mackerel	Squid	Sword Fish	Threadfin Breams	White Shrimp	Yellowfin Tuna	Spadefish
1976	9,015	7,513	13,079	1,558	26,584	20,307	31,633	229
1977	9,145	6,684	12,784	2,102	19,814	10,455	50,799	322
1978	9,701	7,779	10,016	848	14,279	9,281	41,510	583
1979	14,294	11,415	13,665	3,820	16,167	9,992	37,817	880
1980	15,791	9,664	13,235	1,715	19,956	9,757	36,527	636
1981	16,430	11,736	17,813	1,936	25,726	11,784	36,103	524
1982	13,519	15,399	12,000	3,114	20,562	11,693	32,135	1,354
1983	14,228	14,604	19,718	2,959	24,383	10,905	41,529	1,972
1984	16,801	9,577	10,005	2,272	28,707	9,425	36,670	1,482
1985	18,814	10,539	16,127	2,035	31,011	10,878	42,108	1,558
1986	19,869	14,039	16,378	2,088	35,188	14,770	42,752	1,082
1987	17,710	16,573	14,989	2,046	36,522	10,253	33,280	1,050

Table 29. Average Market Wholesale Price of Marine Fish Species, 1994

Species	Price/Mt. (Pesos)
Commercial Species	49,742
Municipal Species	28,250
Average	38,996

Source: BAS (1994). "Fishery Statistics".

CHAPTER X

RESULTS OF ESTIMATION

10.1 Results for Commercial Fisheries

10.1.1 Estimation of the GS and Fox Models for Commercial Fisheries

The results of the estimation of the biological specification of the GS and Fox models are provided in **Table 30.** As seen, the GS model had a higher adjusted coefficient of multiple determination. Both models generated the expected signs and significance for the coefficients suggesting that commercial fisheries are overfished.

10.1.2 Maximum Sustainable, Maximum Economic and Open Access Levels in Commercial Fisheries

Using the results of the GS model in **Table 21** and the values for the price of fish and cost of effort in **Tables 22 and 23,** the MEY, Emey, MSY, Emsy, OAY and Eoay levels were computed **(Tables 31 and 32).** As indicated, MSY was at 785,706 metric tons valued at P39.084 billion and produced at the effort level of 1,833,191 horsepower. When these estimated values were compared with catch and effort values in **Table 18,** the MSY level appeared to have occured back in the early nineties.

The MEY, on the other hand, was at 674,476 metric tons valued at P33.550 billion and produced at the effort level of 1,143,447 horsepower. Comparing with the figures in **Table 18,** this level appeared to have been attained back in the late eighties and early nineties.

The OAY was at 737,579 metric tons valued at P36.687 billion and produced at effort level of 2,286,894 horsepower. Comparing with figures in **Table 18,** This level has yet to happen, implying that with open access, further expansion of the sector will likely occur.

The results of estimation of the GS model of the commercial fisheries are illustrated in **Figure 14.**

10.1.3 Economic Rent in Commercial Fisheries

The computed total revenues, total costs and economic rents using the results of the GS model are also provided in **Tables 31 and 32.** The maximum economic rent that will be generated when the commercial fisheries is operated at MEY level is P15.205 billion per year **(see Figure 14).** On the other hand, if operated at MSY, the economic rent is P9.673 billion annually.

Table 30. Regression Results for the Gordon-Schaefer and Fox Models in the Philippine Commercial Fisheries, 1948-94

Specification (a)	Model	a1	a2	Adjusted R2
Catch = a1 Effort + a2 Effort2	Gordon-Schaefer	.8572* (21.676)	-.0000002338* (-8.654)	.85
Catch = Effort Exp(a1 + a2 Effort)	Fox	.4588* (7.760)	-.000000888* (-12.154)	.76

Figures in parenthesis are t-values. * means significant at the 1 percent level.
(a) Catch and effort are in quantity terms.

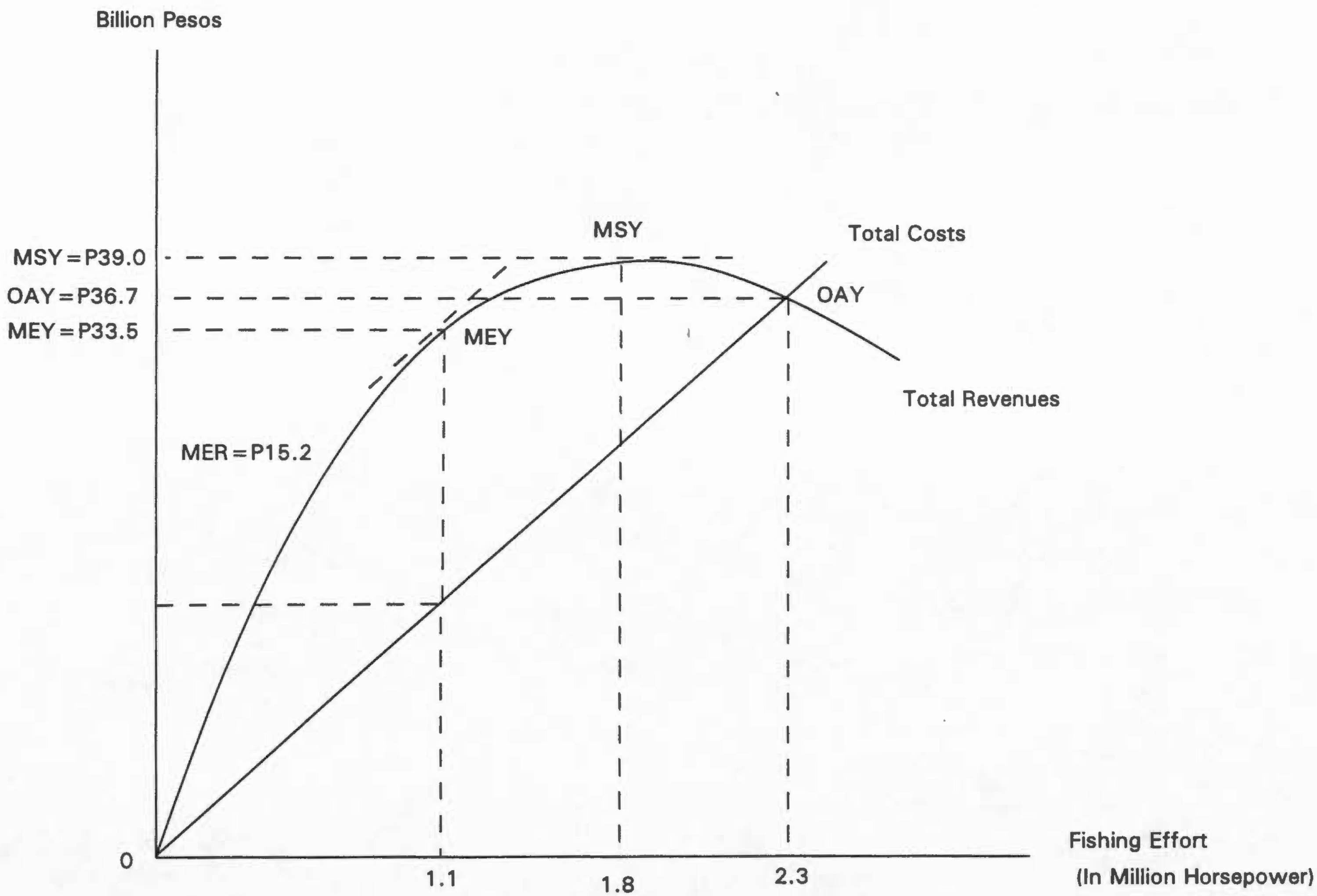
Table 31. Key Indicators Using the Gordon-Schaefer Model Results in the Philippine Commercial Fisheries, 1994

Indicator	Volume of Catch (Metric Tons)	Total Revenues (Pesos)	Amount of Effort (Horsepower)	Total Costs (Pesos)	Economic Rent (Pesos)
Maximum Sustainable point	785,706	39,082,565,981	1,833,191	29,409,879,384	9,672,686,597
Maximum Economic Point	674,476	33,549,785,675	1,143,447	18,344,318,773	15,205,466,902
Open Access Point	737,579	36,688,637,546	2,286,894	36,688,637,546	0

Table 32. Estimated Total Revenues and Total Costs at Different levels of Effort in the Philippine Commercial Fisheries Based on the Gordon-Schaefer Model

Effort	Catch	Total Revenues	Total Costs	Economic Rent
0	0	0	0	0
100,000	83,382	4,147,587,444	1,804,300,000	2,543,287,444
200,000	162,068	8,062,581,296	3,208,600,000	4,853,981,296
300,000	236,118	11,744,981,556	4,812,900,000	6,932,081,556
400,000	305,472	15,194,788,224	6,417,200,000	8,777,588,224
500,000	370,150	18,412,001,300	8,021,500,000	10,390,501,300
600,000	430,152	21,396,620,784	9,625,800,000	11,770,820,784
700,000	485,478	24,148,646,676	11,230,100,000	12,918,546,676
800,000	536,128	26,668,078,976	12,834,400,000	13,833,678,976
900,000	582,102	28,954,917,684	14,438,700,000	14,516,217,684
1,000,000	623,400	31,009,162,800	16,043,000,000	14,966,162,800
1,100,000	660,022	32,830,814,324	17,647,300,000	15,183,514,324
1,143,447	**674,476**	**33,549,787,123**	**18,344,320,221**	**15,205,466,902**
1,200,000	691,968	34,419,872,256	19,251,600,000	15,168,272,256
1,300,000	719,238	35,776,336,596	20,855,900,000	14,920,436,596
1,400,000	741,832	36,900,207,344	22,460,200,000	14,440,007,344
1,500,000	759,750	37,791,484,500	24,064,500,000	13,726,984,500
1,800,000	772,992	38,450,168,064	25,668,800,000	12,781,368,064
1,700,000	781,558	38,876,258,036	27,273,100,000	11,603,158,036
1,800,000	785,448	39,069,754,416	28,877,400,000	10,192,354,416
1,833,191	**785,706**	**39,082,565,981**	**29,409,879,384**	**9,672,686,597**
1,900,000	784,662	39,030,657,204	30,481,700,000	8,548,957,204
2,000,000	779,200	38,758,966,400	32,086,000,000	6,672,966,400
2,100,000	769,062	38,254,682,004	33,690,300,000	4,564,382,004
2,200,000	754,248	37,517,804,016	35,294,800,000	2,223,204,016
2,286,894	**737,579**	**36,688,637,546**	**36,688,637,546**	**(0)**
2,300,000	734,758	36,548,332,436	36,898,900,000	(350,567,564)
2,400,000	710,592	35,346,267,264	38,503,200,000	(3,156,932,736)
2,500,000	681,750	33,911,608,500	40,107,500,000	(6,195,891,500)
2,600,000	648,232	32,244,356,144	41,711,800,000	(9,467,443,856)
2,700,000	610,038	30,344,510,196	43,316,100,000	(12,971,589,804)
2,800,000	567,168	28,212,070,656	44,920,400,000	(16,708,329,344)
2,900,000	519,622	25,847,037,524	46,524,700,000	(20,677,662,476)
3,000,000	467,400	23,249,410,800	48,129,000,000	(24,879,589,200)

Figure 14. Results of the Estimation of the Gordon-Schaefer Model for the Commercial Fisheries, 1948-1994



Expressed in terms of quantity at the 1994 average fish price of P49,742 per metric ton, the maximum economic rent that can be had from the commercial fisheries per year amount to 305,677 metric tons.

The above estimate of the amount of the maximum economic rent from commercial fisheries, in general, is consistent with results of previous studies. Dalzell et al. (1987) measured that maximum economic rent from small pelagic fisheries was about 366,000 metric tons. On the other hand, Silvetre and Pauly (1986) estimated the maximum economic rent from the demersal fisheries at approximately 125,000 to 200,000 metric tons or 162,500 metric tons on average per year. When summed up, the maximum economic rent from the small pelagic and demersal fisheries was at 528,500 metric tons.

Little is known about how much of small pelagic and demersal catch came from commercial fisheries. However, the average share of commercial fisheries catch to total marine fisheries catch in the last five years was 47 percent (BAS, Various Years). Using this as a rough basis, then the commercial fisheries share of the maximum economic rent coming from the small pelagic and demersal fisheries was about 248,395 metric tons a year.

There is no information about the maximum economic rent from large pelagic fisheries, much less about the portion of this that goes to commercial fisheries. On the other hand, it can be assumed that the difference between the figure of 248,395 metric tons from past studies and the figure of 305,677 metric tons computed by this study represents the economic rent from large pelagic fisheries.

10.1.4 Required Reduction of Fishing Effort in Commercial Fisheries

Based on the results, fishing effort needs to be reduced from the 1994 level of 2,091,899 horsepower **(Table 18).** In percentage terms, effort in the commercial fisheries sector will have to be reduced by about 45 percent to arrive at MEY. To attain the MSY, on the other hand, it will have to be lowered by approximately 12 percent.

10.1.5 Estimation of the GS and Fox Models for Purse Seine and Other Commercial Fishing Gears

To see if overfishing is occurring at the gear level, the GS and Fox models were estimated for purse seine and other commercial gears. The results of estimation are provided in **Table 33.** For purse seine, the GS model showed better goodness-of-fit while for other gears, the Fox model provided superior fit. The coefficients have the right signs. Furthermore, all the coefficients are highly significant, implying that at the gear level, overfishing occurs in the commercial fisheries sector.

Table 33. Regression Results for the Gordon-Schaefer and Fox Models for Purse Seine and Other Gears, 1948-94

Specification (a)	Model	a1	a2	Adjusted R2
1. Purse Seine				
Catch = a1 Effort + a2 Effort2	Gordon-Schaefer	1.5949* (15.384)	-.00000156* (-4.612)	.92
Catch = Effort Exp(a1 + a2 Effort)	Fox	1.5849* (18.261)	-.00000575* (-10.091)	.69
2. Other Gears				
Catch = a1 Effort + a2 Effort2	Gordon-Schaefer	.7509* (16.714)	-.000000317* (-8.280)	.36
Catch = Effort Exp(a1 + a2 Effort)	Fox	.4354* (6.702)	-.00000142* (-14.425)	.82

Figures in parenthesis are t-values. * means significant at the 1 percent level.
(a) Catch and effort are in quantity terms.

10.2 Results for Municipal Fisheries

10.2.1 Estimation of the GS and Fox Models for Municipal Fisheries

The results of the estimation of the GS and Fox models for the municipal fisheries are presented in **Table 34.** As indicated, the latter had a higher adjusted coefficient of multiple determination. Both GS and Fox models had the expected signs and significance for the coefficients implying that municipal fisheries are overfished.

10.2.2 Maximum Sustainable, Maximum Economic and Open Access Levels in Municipal Fisheries

For consistency, the GS model again was utilized to estimate the MSY, MEY and OAY for municipal fisheries **(Table 35 and 36).** The MSY was at 1,058,263 metric tons valued at P29.89 billion and attained at effort level of 3,823,204 horsepower. Compared with the catch and effort levels in **Table 25,** the MSY in the municipal fisheries was apparently reached in the late eighties and early nineties.

In contrast, the MEY was at 779,824 metric tons valued at P22 billion and attained at the effort level of 1,862,123 horsepower. Comparing with figures in **Table 25,** this appeared to have been attained back in the early eighties.

The OAY was at 1,057,554 metric tons valued at P29.87 and achieved at the effort level of 3,724,246 horsepower. Compared to figures in **Table 25**, it appeared that this level was apparently attained in the early nineties.

An illustration of the GS model for commercial fisheries is presented in **Figure 15.** A rather unique situation in the municipal fisheries is that the OAY was attained before the MSY was reached, in contrast to the situation in the commercial fisheries.

10.2.3 Economic Rent in Municipal Fisheries

Tables 35 and 36 also contained the computed total revenues, total costs and economic rents using the results of the GS model. If operated at MEY, the maximum economic rent that can be derived from the municipal fisheries is about P7.095 billion per year **(see Figure 15).** If operation is at MSY, the economic rent is negative, at P.77 billion annually.

At the assumed 1994 average price for municipal fish species of P28,250 per metric ton, the maximum economic rent that will be derived from municipal fisheries amounts to 251,047 metric tons.

Again, this result appears consistent with those of previous studies. Recalling back, from past studies, the estimated maximum economic rent from the small pelagic and demersal fisheries was at 528,500 metric tons. Assuming that the average share of municipal fisheries catch to marine

Table 34. Regression Results for the Gordon-Schaefer and Fox Models in the Philippine Municipal Fisheries, 1948-94

Specification (a)	Model	a1	a2	Adjusted R2
Catch = a1 Effort + a2 Effort2	Gordon-Schaefer	.5536* (15.420)	-.0000000724* (-10.145)	.55
Catch = Effort Exp(a1 + a2 Effort)	Fox	.3761* (5.202)	-.00000046* (-15.044)	.83

Figures in parenthesis are t-values. * means significant at the 1 percent level.
(a) Catch and effort are in quantity terms.

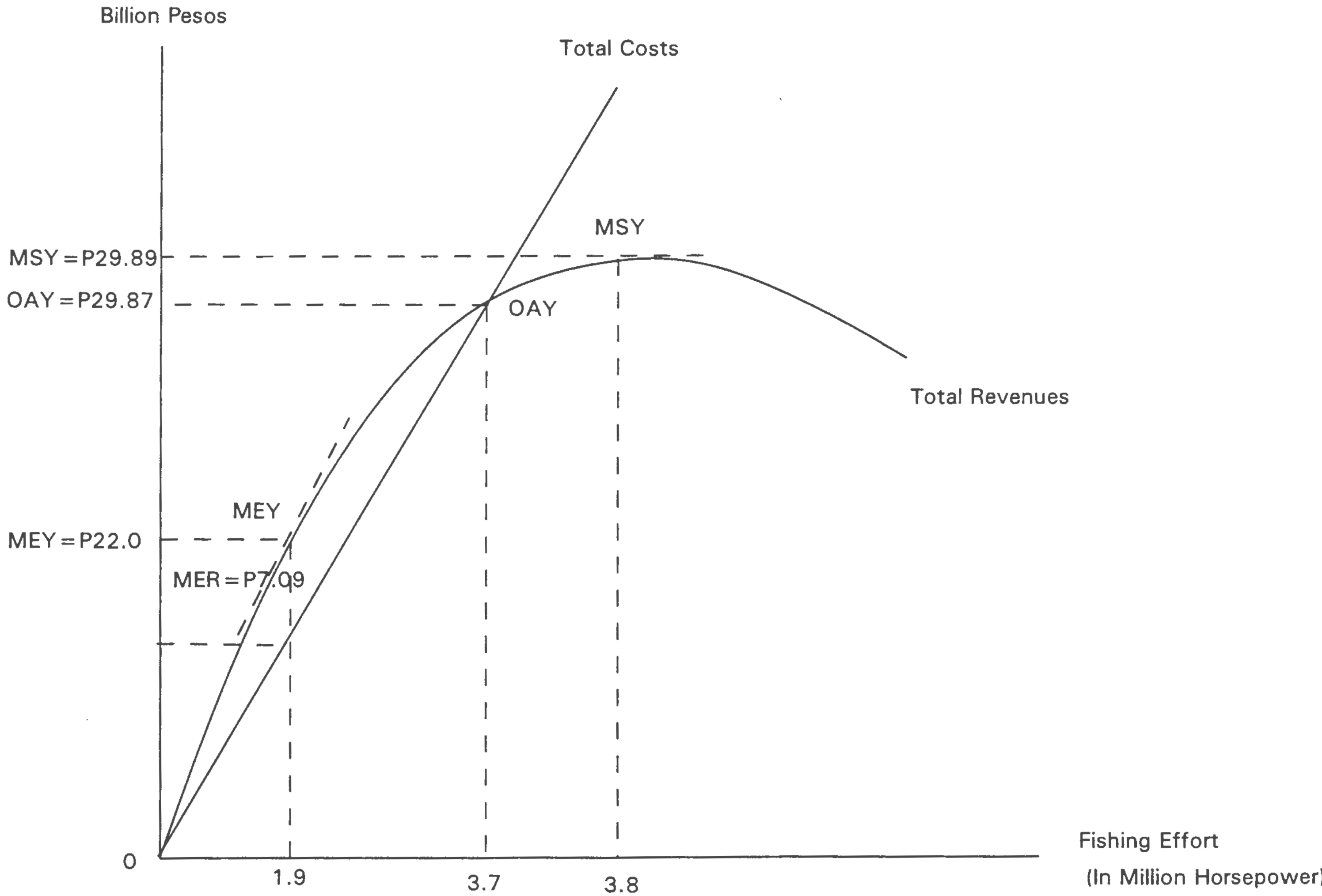
Table 35. Key Indicators Using the Gordon-Schaefer Model Results in the Philippine Municipal Fisheries, 1994

Indicator	Volume of Catch (Metric Tons)	Total Revenues (Pesos)	Amount of Effort (horsepower)	Total Costs (Pesos)	Economic Rent (Pesos)
Maximum Sustainable point	1,058,263	29,895,929,282	3,823,204	30,669,745,856	(773,816,575)
Maximum Economic Point	779,824	22,030,031,369	1,862,123	14,937,950,032	7,092,081,338
Open Access Point	1,057,554	29,875,900,064	3,724,246	29,875,900,064	0

Table 36. Estimated Total Revenues and Total Costs at Different levels of Effort in the Philippine Municipal Fisheries Based on the Gordon-Schaefer Model

Effort	Catch	Total Revenues	Total Costs	Economic Rent
100,000	54,636	1,543,467,000	802,200,000	741,267,000
200,000	107,824	3,046,028,000	1,604,400,000	1,441,628,000
300,000	159,564	4,507,683,000	2,406,600,000	2,101,083,000
400,000	209,856	5,928,432,000	3,208,800,000	2,719,632,000
500,000	258,700	7,308,275,000	4,011,000,000	3,297,275,000
600,000	306,096	8,647,212,000	4,813,200,000	3,834,012,000
700,000	352,044	9,945,243,000	5,615,400,000	4,329,843,000
800,000	396,544	11,202,368,000	6,417,600,000	4,784,768,000
900,000	439,596	12,418,587,000	7,219,800,000	5,198,767,000
1,000,000	481,200	13,593,900,000	8,022,000,000	5,571,900,000
1,100,000	521,356	14,728,307,000	8,824,200,000	5,904,107,000
1,200,000	560,064	15,821,808,000	9,626,400,000	6,195,408,000
1,300,000	597,324	16,874,403,000	10,428,600,000	6,445,803,000
1,400,000	633,136	17,886,092,000	11,230,800,000	6,655,292,000
1,500,000	667,500	18,856,875,000	12,033,000,000	6,823,875,000
1,862,123	**779,824**	**22,030,032,044**	**14,937,950,706**	**7,092,081,338**
1,600,000	700,416	19,788,752,000	12,835,200,000	6,951,552,000
1,700,000	731,884	20,675,723,000	13,637,400,000	7,038,323,000
1,800,000	761,904	21,523,768,000	14,439,800,000	7,084,168,000
1,900,000	790,476	22,330,947,000	15,241,800,000	7,089,147,000
2,000,000	817,600	23,097,200,000	16,044,000,000	7,053,200,000
2,100,000	843,276	23,822,547,000	16,846,200,000	6,976,347,000
2,200,000	867,504	24,506,988,000	17,648,400,000	6,858,588,000
2,300,000	890,284	25,150,523,000	18,450,600,000	6,699,923,000
2,400,000	911,616	25,753,152,000	19,252,800,000	6,500,352,000
2,500,000	931,500	26,314,875,000	20,055,000,000	6,259,875,000
2,600,000	949,936	26,835,692,000	20,857,200,000	5,976,492,000
2,700,000	966,924	27,315,603,000	21,659,400,000	5,658,203,000
2,800,000	982,464	27,754,608,000	22,481,800,000	5,293,008,000
2,900,000	996,556	28,152,707,000	23,263,800,000	4,888,907,000
3,000,000	1,009,200	28,509,900,000	24,066,000,000	4,443,900,000
3,823,204	**1,058,263**	**29,895,929,282**	**30,669,745,856**	**(773,816,575)**
3,100,000	1,020,396	28,826,167,000	24,868,200,000	3,957,987,000
3,200,000	1,030,144	29,101,568,000	25,670,400,000	3,431,168,000
3,300,000	1,038,444	29,336,043,000	26,472,600,000	2,863,443,000
3,400,000	1,045,296	29,529,612,000	27,274,800,000	2,254,612,000
3,500,000	1,050,700	29,682,275,000	28,077,000,000	1,605,275,000
3,600,000	1,054,656	29,794,032,000	28,879,200,000	914,832,000
3,700,000	1,057,164	29,864,883,000	29,681,400,000	183,483,000
3,800,000	1,058,224	29,894,828,000	30,483,600,000	(588,772,000)
3,724,246	**1,057,554**	**29,875,900,064**	**29,875,900,064**	**0**
3,900,000	1,057,836	29,883,667,000	31,285,800,000	(1,401,933,000)
4,000,000	1,056,000	29,832,000,000	32,088,000,000	(2,256,000,000)

Figure 15. Results of the Estimation of the Gordon-Schaefer Model for the Municipal Fisheries, 1948-1994



fisheries catch was 53 percent, then the municipal fisheries share of the maximum economic rent coming from the small pelagic and demersal fisheries was about 280,105 metric tons a year.

While there is no information on the economic rent from large pelagic fisheries, it can be assumed that large pelagic species are mostly caught by commercial fishermen. Therefore, the extrapolated maximum economic rent of 280,105 metric tons for small pelagic and demersal fisheries can be taken as the rent for municipal fisheries as a whole. This figure is clearly not way off the figure derived by the study.

10.2.4 Required Reduction of Fishing Effort in Municipal Fisheries

To attain sustainable levels, the fishing effort in municipal fisheries has to be lowered from the level of 6,343,329 horsepower in 1994 **(Table 25).** Percentage-wise, fishing effort will have to decrease by 71 percent to attain MEY. To get to the MSY level, on the other hand, it will have to be reduced by 40 percent (It should be noted, however, that since MSY falls beyond the OAY level, it is not a desirable management objective in this case).

10.3 Results for Overall Marine Fisheries

Table 37 presents the results of the estimation of the GS and Fox models for the overall marine fisheries sector. It is shown that the former model had a higher adjusted coefficient of multiple determination. Also, both models generated the signs and levels of significance for the coefficients which were expected, indicating that overfishing is a problem for the entire marine fisheries.

10.3.1 Estimation of the GS and Fox Models for Overall Marine Fisheries

Table 37 presents the results of the estimation of the GS and Fox models for the overall marine fisheries sector. It is shown that the former model had a higher adjusted coefficient of multiple determination. Also, both models generated the signs significance for the coefficients which were expected, implying that the problem of overfishing occurs for marine fisheries as a whole (This result, however, is anticipated already given that both the commercial and municipal fisheries, its two components, were already found to be overfished earlier).

10.3.2 Maximum Sustainable, Maximum Economic and Open Access Levels in Overall Marine Fisheries

The estimates of the MSY, MEY and OAY for marine fisheries are provided in **Tables 38 and 39.** The MSY was at 1,803,727 metric tons valued at P70.3 billion and arrived at effort level of 5,505,882 horsepower. Contrasted to the catch and effort figures in **Table 27**, the MSY appeared to have been reached in the late eighties and early nineties.

Table 37. Regression Results for the Gordon-Schaefer and Fox Models in the Philippine Marine Fisheries, 1948-94

Specification (a)	Model	a1	a2	Adjusted R2
Catch = a1 Effort + a2 Effort2	Gordon-Schaefer	.6552*	-.0000000595*	.66
		(17.054)	(-10.043)	
Catch = Effort Exp(a1 + a2 Effort)	Fox	.3890*	-.000000299*	.62
		(6.039)	(-14.647)	

Figures in parenthesis are t-values. * means significant at the 1 percent level.
(a) Catch and effort are in quantity terms.

Table 38. Key Indicators Using the Gordon-Schaefer Model Results in the Philippine Marine Fisheries, 1994

Indicator	Volume of Catch (Metric Tons)	Total Revenues (Pesos)	Amount of Effort (horsepower)	Total Costs (Pesos)	Economic Rent (Pesos)
Maximum Sustainable point	1,803,727	70,338,140,386	5,505,882	66,246,776,471	4,091,363,915
Maximum Economic Point	1,403,728	54,739,791,579	2,913,072	35,050,078,856	19,689,712,722
Open Access Point	1,797,624	70,100,157,713	5,826,143	70,100,157,713	0

Table 39. Estimated Total Revenues and Total Costs at Different levels of Effort in the Philippine Marine Fisheries Based on the Gordon-Schaefer Model

Effort	Catch	Total Revenues	Total Costs	Economic Rent
0	0	0	0	0
200,000	128,660	5,017,225,360	2,406,400,000	2,610,825,360
400,000	252,560	9,848,829,760	4,812,800,000	5,036,029,760
600,000	371,700	14,494,813,200	7,219,200,000	7,275,613,200
800,000	486,080	18,955,175,680	9,825,600,000	9,329,575,680
1,000,000	595,700	23,229,917,200	12,032,000,000	11,197,917,200
1,200,000	700,560	27,319,037,760	14,438,400,000	12,880,637,760
1,400,000	800,660	31,222,537,360	16,844,800,000	14,377,737,360
1,600,000	896,000	34,940,416,000	19,251,200,000	15,689,216,000
1,800,000	986,580	38,472,673,680	21,657,600,000	16,815,073,680
2,000,000	1,072,400	41,819,310,400	24,064,000,000	17,755,310,400
2,200,000	1,153,460	44,980,326,160	26,470,400,000	18,509,926,160
2,400,000	1,229,760	47,955,720,960	28,876,800,000	19,078,920,960
2,600,000	1,301,300	50,745,494,800	31,283,200,000	19,462,294,800
2,800,000	1,368,080	53,349,647,680	33,689,600,000	19,660,047,680
2,913,072	**1,403,728**	**54,739,791,579**	**35,050,078,856**	**19,689,712,722**
3,000,000	1,430,100	55,768,179,800	36,096,000,000	19,672,179,600
3,200,000	1,487,360	58,001,090,560	38,502,400,000	19,498,690,560
3,400,000	1,539,860	60,048,380,560	40,908,800,000	19,139,580,560
3,600,000	1,587,800	61,910,049,600	43,315,200,000	18,594,849,600
3,800,000	1,630,580	63,586,097,680	45,721,600,000	17,864,497,680
4,000,000	1,868,800	85,076,524,800	48,128,000,000	16,948,524,800
4,200,000	1,702,260	66,381,330,960	50,534,400,000	15,846,930,960
4,400,000	1,730,960	67,500,516,160	52,940,800,000	14,559,716,160
4,600,000	1,754,900	68,434,080,400	55,347,200,000	13,086,880,400
4,800,000	1,774,080	69,182,023,680	57,753,800,000	11,428,423,680
5,000,000	1,788,500	69,744,346,000	60,160,000,000	9,584,346,000
5,200,000	1,798,180	70,121,047,360	62,566,400,000	7,554,647,360
5,400,000	1,803,060	70,312,127,760	64,972,800,000	5,339,327,760
5,505,882	**1,803,727**	**70,338,140,385**	**66,246,776,470**	**4,091,363,915**
5,600,000	1,803,200	70,317,587,200	67,379,200,000	2,938,387,200
5,800,000	1,798,580	70,137,425,680	69,785,600,000	351,825,680
5,826,143	**1,797,624**	**70,100,157,713**	**70,100,157,713**	**(0)**
6,000,000	1,789,200	69,771,643,200	72,192,000,000	(2,420,356,800)
6,200,000	1,775,060	69,220,239,760	74,598,400,000	(5,378,160,240)
6,400,000	1,756,180	68,483,215,360	77,004,800,000	(8,521,584,640)
6,600,000	1,732,500	67,560,570,000	79,411,200,000	(11,850,630,000)

The MEY was at 1,403,728 metric tons valued at P54.7 billion and generated at the effort level of 2,913,072 horsepower. Contrasted to figures in **Table 25,** was apparently attained in the early eighties.

Lastly, the OAY was at 1,797,624 metric tons valued at P70.1 billion and attained at the effort level of 5,826,143 horsepower. Compared to figures in **Table 25,** this was already reached in the early nineties.

An illustration of the GS model for overall marine fisheries is shown in **Figure 16.**

10.3.3 Economic Rent in Overall Marine Fisheries

The computed total revenues, total costs and economic rents using the GS model are also shown in **Table 38 and 39.** At MEY, the maximum economic rent that can be derived from the overall marine fisheries is about P19.689 billion per year. At MSY, the economic rent is at P4.091 billion annually.

It can be seen that the generated MEY and MSY levels for the overall marine fisheries divert a bit from the sum of the derived MEY and MSY levels for commercial and municipal fisheries **(Tables 31, 32, 35 and 36).** This result, however, is expected given the differences in fish catch and fishing effort prices utilized in the computations.

At the assumed 1994 average price for marine fish species of P38,996 per metric ton, the maximum economic rent that can be had amounts to 504,916 metric tons. Again, this figure is in general consistent with those generated from previous studies.

10.3.4 Required Reduction of Fishing Effort in Overall Marine Fisheries

The above result implies that the fishing effort in overall marine fisheries has to be decreased from the level of 8,435,228 horsepower in 1994 **(Table 27).** In particular, fishing effort will have to decrease by 65 percent to attain MEY. On the other hand, it will have to lower by 35 percent to attain MSY.

10.4 Results for Individual Fish Species in Marine Fisheries

Table 40 presents the results of estimation of the biological models of overfishing for the 35 most important species in marine fisheries. Only the results of the model that has better fit are presented.

It can be seen that overall, the coefficients of multiple determination were low. This can be an indication that both the GS and Fox models, as specified here, may not be the most appropriate model for explaining the situation for individual species in marine fisheries (For instance, variables other than fishing effort may contribute to individual fish species catch. Their addition in the model

Figure 16. Results of the Estimation of the Gordon-Schaefer Model for the Overall Marine Fisheries, 1948-1994

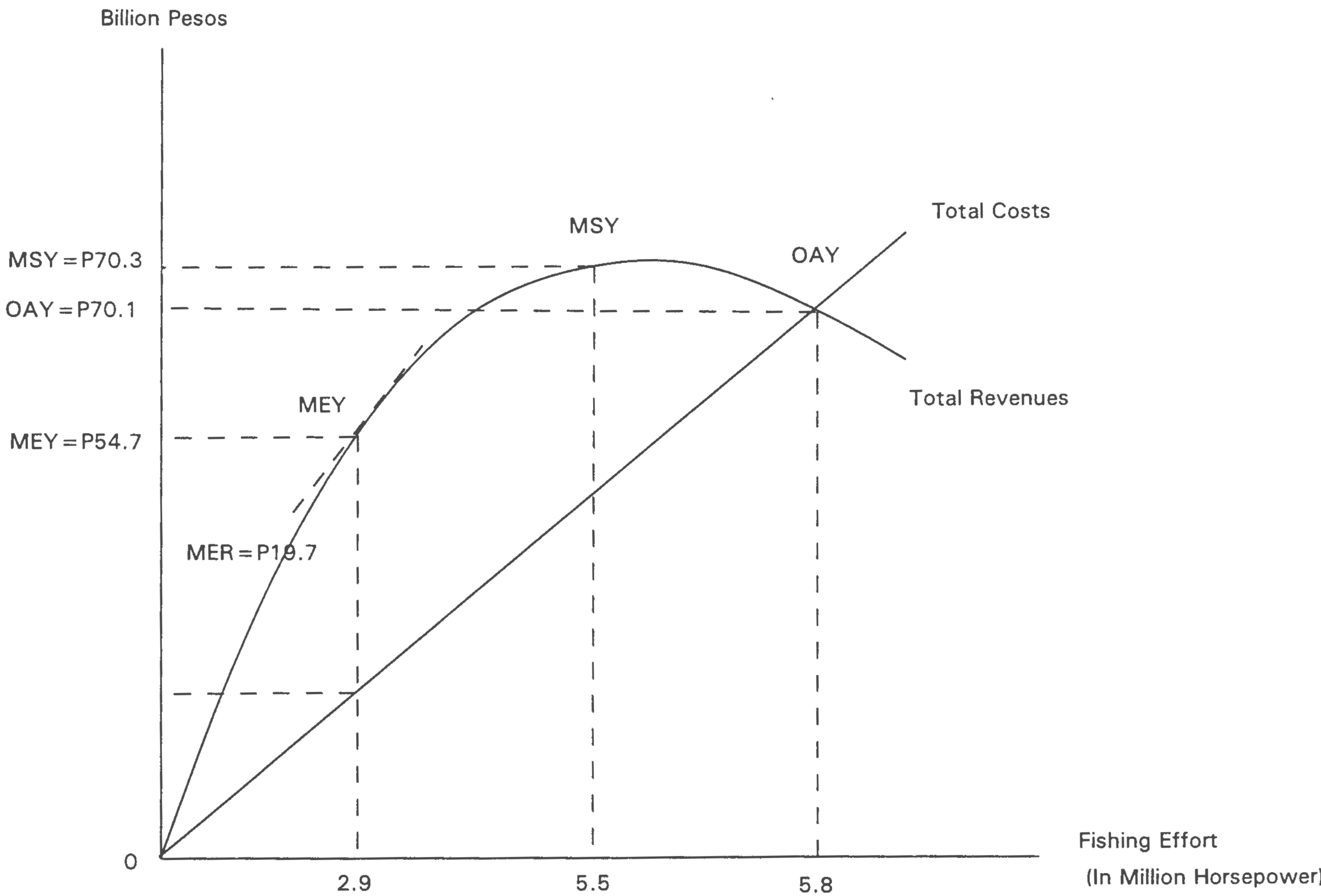


Table 40. Regression Results for the Gordon-Schaefer and Fox Models in the Philippine Marine Fisheries, top Species, 1976-87 (a)

Species	Model	a1	a2	Adjusted R2
Acetes	Gordon-Schaefer	.0058 (2.628)	-.0000000005 (-.806)	.23
Anchovies	Fox	.0331* (11.824)	-.0000000033* (-4.530)	.64
Barracuda	Gordon-Schaefer	.0019* (4.332)	-.00000000065 (-.538)	.55
Big-Eyed Scad	Fox	.0255* (9.594)	-.00000000542* (6.186)	.77
Caesio	Fox	.0068* (12.271)	-.00000000126* (-6.938)	.81
Cavalla	Fox	.0115* (6.316)	-.00000000184* (-3.062)	.43
Crab	Gordon-Schaefer	.0071* (4.888)	-.00000000009 (-2.225)	.27
Crevalle	Fox	.0057* (6.320)	-.000000000575 (-2.684)	.36
Croaker	Gordon-Schaefer	.0020 (2.089)	-.000000000513 (-.195)	.19
Eastern Little Tuna	Fox	.0214* (4.741)	-.00000000281 (-2.700	.36
Flying Fish	Gordon-Schaefer	.0111* (5.412)	-.00000000155 (-2.691)	.23
Frigate Tuna	Fox	.0229* (9.102)	-.00000000331* (-3.996)	.58
Garfish	Gordon-Schaefer	.0003* (4.359)	-.000000000222 (-.986)	.15
Goatfish	Gordon-Schaefer	.0024* (2.287)	-.000000000343 (-1.152)	.71

Figures in parenthesis are t-values. * means significant at the 1 percent level.
(a) Catch and effort are in quantity terms.

Table 40. Regression Results for the Gordon-Schaefer and Fox Models in the Philippine Marine Fisheries, top Species, 1976-87 (Continued)

Species	Model	a1	a2	Adjusted R2
Grouper	Gordon-Schaefer	.0088*	-.000000000748	.56
		(7.316)	(-2.220)	
Hairtail	Gordon-Schaefer	.0046	-.000000000569*	.37
		(8.425)	(-3.767)	
Herring	Fox	.0026*	-.00000000575*	.45
		(4.611)	(-3.137)	
Indian Mackerel	Fox	.0137*	-.00000000248*	.48
		(6.062)	(-3.300)	
Indo-Pacific Mackerel	Fox	.0102*	-.00000000177*	.51
		(6.664)	(-3.555)	
Lizard Fish	Fox	.0158*	-.00000000356*	.71
		(7.807)	(-5.322)	
Mullet	Gordon-Schaefer	.0031*	-.000000000052	.68
		(4.644)	(.283)	
Porgies	Gordon-Schaefer	.0055*	-.000000000583*	.70
		(10.707)	(-4.040)	
Prawn	Gordon-Schaefer	.0007	-.0000000000	.44
		(3.143)	(-.737)	
Round Scad	Fox	.0244*	-.00000000446*	.69
		(9.183)	(-5.104)	
Sardine	Fox	.0686*	-.0000000134*	.64
		(7.694)	(-4.576)	
Shrimp	Fox	.0102*	-.00000000191*	.47
		(5.744)	(-3.280)	
Siganid	Gordon-Schaefer	.0061*	-.000000000634	.47
		(5.075)	(-1.893)	
Skipjack	Fox	.0222*	-.00000000447*	.59
		(6.679)	(-4.130)	

Table 40. Regression Results for the Gordon-Schaefer and Fox Models in the Philippine Marine Fisheries, top Species, 1976-87 (Continued)

Species	Model	a1	a2	Adjusted R2
Slipmouth	Gordon-Schaefer	.0132*	-.00000000107	.46
		(6.267)	(-1.821)	
Snapper	Gordon-Schaefer	.0074*	-.000000000720*	.77
		(10.582)	(-3.689)	
Spanish Mackerel	Gordon-Schaefer	.0056*	-.00000000052	.57
		(6.642)	(-2.212)	
Squid	Fox	.0010*	-.00000000146*	.65
		(9.935)	(-4.594)	
Treadfin Breams	Gordon-Schaefer	.0108*	-.000000000689	.56
		(5.788)	(-1.327)	
White Shrimp	Fox	.0101*	-.0000000019*	.47
		(5.744)	(-3.280)	
Yellowfin Tuna	Fox	.0328*	-.00000000606*	.67
		(8.565)	(-4.803)	

as explanatory variables, then, could improve the goodness of fit of the models. Due, however, to data and resource constraints, this additional work was not tried in the study).

Notwithstanding the above, it is clear that overfishing exists when it comes to individual marine fish species. In particular, the expected signs and levels of significance were derived for 17 of the fish species, including anchovies, big-eyed scad, caesio, cavalla, frigate tuna, hairtail, indian mackerel, indo-pacific mackerel, lizard fish, porgies, roundscad, sardine, skipjack, snapper, squid, white shrimp and yellowfin. From the results, its is also worth noting that tuna and mackerel species are among those overfished in the marine fisheries.

For the rest of the fish species, the results of estimation do not indicate biological overfishing. Among the species are prawns which are also produced locally through brackishwater aquaculture and highly priced in the international market.

10.5 Employment Impacts of Reduction in Effort in Marine Fisheries

A reduction in fishing effort to attain MSY or MEY will raise the productivity of marine fisheries. However, it will also cause unemployment to fishermen who will be eased out of fisheries. This is a major problem in the country where the rest of the economy may not have enough room to accommodate the displaced fishermen.

While it is difficult to exactly estimate employment effects of a reduction in effort, it was attempted here. In **Table 41**, the results are provided. There are two computational approaches used: first, by using the previous results for commercial and municipal fisheries individually and then summing up and, second, by using the previous results for the overall marine fisheries directly.

Based on the 1990 figure of about 1 million total fishermen and fishfarmers and annual growth rates of the general population thereafter, the 1994 total fishermen and fishfarmers was 1,103,230. Of these, 29 percent or 319,937 were commercial fishermen while 36 percent or 397,163 were municipal fishermen **(see Figure 1).**

To attain MSY, effort will be decreased by 12 percent in the commercial fisheries and 40 percent in the municipal fisheries. If this reduction is applied equally to labor and engine horsepower, then commercial fishermen will be reduced by 38,392 while municipal fishermen will be lowered by 158,865. In total, using the previous individual results for the commercial and municipal fisheries, the number of marine fishermen will decrease by 197,258.

When results for overall marine fishermen were used, effort will be reduced by 35 percent to attain MSY. This means that 250,985 fishermen will lose their jobs (Again, it must be noted that computations based on individual and total results differ due to reasons already stated). Getting the range, then, about one-fifth to quarter of a million fishermen will be unemployed if MSY is to be attained in the marine fisheries.

Table 41. Estimated Employment Impacts on a Reduction of Fishing Effort to Attain MSY and MEY, 1994

Sector	Maximum Sustainable Yield			Maximum Economic Yield		
	Percent Decrease in Effort	Current Number of Fishermen (a)	Decrease in Employment	Percent Decrease in Effort	Current Number of Fishermen (a)	Decrease in Employment
Commercial	12	319,937	38,392	45	319,937	143,972
Municipal	40	397,163	158,865	71	397,163	281,986
Sum			197,258			425,957
Overall Marine	35	717,100	250,985	65	717,100	466,115

(a) To derive the figures for number of fishermen, general population growth rates from 1990-94 were taken from the NCSO "Philippine Statistical Yearbook". Then the 1994 fishermen population was computed based on the growth rates and the 1990 figure of 1 million total fishermen. The derived 1994 figure was multiplied by the ratio of commercial and commercial and municipal fishermen shown in Figure 1.

To arrive at MEY, on the other hand, effort must be lowered by 45 percent commercial fisheries and by 710 percent in the municipal fisheries. Again, if this reduction is applied equally to labor and engine horsepower, then commercial fishermen will be reduced by 143,972 and municipal fishermen will be lowered by 281,986 for a sum of 425,957.

If results for overall marine fishermen were utilized, effort will be lowered by 65 percent to get MEY. This means that 466,115 people will be unemployed. Thus, from this and the above results, approximately half a million fishermen will lose work if MSY is to be attained in the marine fisheries.

In brief, a large number of fishermen will lose their jobs if efficiency and sustainability will be attained in marine fisheries. Since the country already has a serious unemployment problem, this fishery management concern cannot be ignored.

CHAPTER XI

PART II: CONCLUSIONS AND RECOMMENDATIONS

11.1 Conclusions

From the results of estimation discussed in the past chapter, the study generated the following conclusions about overfishing in the marine fisheries sector:

a. The marine fisheries sector and its two subsectors, commercial and municipal fisheries are already overfished. This sector based finding is consistent with results of previous studies employing group of species analysis.

b. There is also overfishing in the use of specific gears in the commercial fisheries subsector, i.e., purse seine and other gears taken together.

c. Likewise, there is overfishing in some important marine fish species, including tuna and mackerel species. However, there are also species which are not overfished yet, such as prawns.

d. In general, MEY and MSY levels in the marine fisheries sector and its subsectors have been reached during the early eighties to early nineties.

e. Substantial economic rents can be had if the marine fisheries sector is operated at sustainable levels. Taken separately, if operated at MEY, maximum economic rent from the commercial fisheries will be about P15.205 billion at 1994 prices while that from the municipal fisheries will be approximately P7.095 billion. Taken as a whole, the maximum economic rent from the marine fisheries sector will be P19.689 billion.

f. Substantial reduction in fishing effort will be required to reach sustainable levels in the marine fisheries. Considered separately, if operated at MEY, effort in commercial fisheries will be decreased by 45 percent while that in the municipal fisheries will be lowered by 71 percent. Taken as a whole, for marine fisheries, effort must be decreased by 65 percent.

g. Because of the needed substantial decreases in fishing effort for the attainment of sustainability in the marine fisheries, unemployment will be a serious potential side-effect. Taken individually, approximately 144,000 commercial fishermen and 290,000 municipal fishermen will lose their jobs if the MEY level is attained in the subsectors. Overall, about 466,000 marine fishermen will be unemployed.

Before recommendations can be derived from the aforementioned conclusions, caveats have to be stated. Firstly, the exploitation levels and economic rents generated by the study clearly depend to a large extent on the price of fish and cost of effort assumed in the analysis. A decreased price of fish or an increased cost of effort, for instance, may substantially reduce the value of the estimated economic rent that can be generated from the sector, and vice versa.

The estimate of price of fish in this study was considered the best estimate in the absence of any other source, however. On the other hand, the estimate of the cost of fishing effort may have to be changed or updated, based on a recent survey.

Secondly, it must be mentioned that since some of the annual data, e.g. horsepower in the later years and catch in earlier years for the commercial fisheries, were simply estimated, there will be concerns as to the reliability and accuracy of the estimated data. The data on effort after 1988, in particular, were adjusted upwards to match the overestimated catch data and maintain the trend in the catch per unit effort. Suffice it to say here that the particular procedures used in the estimation of these data were selected based to a large extent on their usefulness in reducing data inaccuracy.

Thirdly, the GS and Fox models are partial models in that they only consider fishing effort as the factor influencing fish catch. Although in this study, learning (and, hence, in a way technology), has been imputed as a factor, other determinants of fish catch were excluded, such as the macroeconomic and sectoral policies or a year long bad weather, for instance. The extent by which these factors and other factors influence fishing has not been investigated here.

Finally, there is the need to disaggregate "other gears" in the commercial fisheries into specific gears to see if specific commercial gears likewise endulge in overfishing. There has been numerous fishing gears in recent years and their very large number discouraged disaggregation for this work. In the future, effort can be made to analyze further overfishing by specific gears, both in the commercial and municipal fisheries.

11.2 Recommendations

11.2.1 Recommendations for Commercial Fisheries

Based on findings and conclusions for the commercial fisheries subsector, these recommendations related to the conservation and further development may be considered:

a. Since total commercial fisheries are already overfished, then this overexploitation must be contained by decreasing fishing effort. Also, since overfishing exists at present, there is the immediate need to freeze the fleet level at the least to its current size. A moratorium on the issuance of licences to operate is prudent.

b. The reduction in fishing effort must be done in such a manner that the costs of reduction (e.g. administrative costs, rent seeking costs, etc.) will exceed the gains from the reduction (e.g. public revenues, sustainable use of fishery resources, production efficiency, etc.).

c. Athough theoretically, market-based instruments are known to be superior to command and control instruments, the choice of instruments to effect (b) actually have to be a combination of both. Furthermore, it will help if the instruments to be used are those that authorities already have some experience using.

d. The licence system has been enforced in commercial fisheries for some time now although the rates have been low to effect any real effort reduction. Because of the experience of the fishery authorities in using it, the system may continuously be applied in the future, but at much higher rates that will result, at the least partially, to the reduction in fishing effort.

e. While commercial fisheries may have a high maximum economic rent computed in this study, the actual economic rent it has been enjoying presently is much less given that the subsector is operating close to open access equilibrium. So as not to encourage sudden dislocation and closure among the commercial fishermen, the licence rates must be set way below maximum economic rent initially.

f. In addition, the increases in licence rates have to done gradually to allow adjustment among the fishermen. In the first year of implementation, for instance, the rates may not be more than, say, 20 percent of the final targetted maximum rates for the attainment of sustainability levels. Then, the rates can be increased yearly at the same percentage every two years thereafter.

g. There is doubt, however, that the licencing scheme will be effective in reducing fishing effort in the long-term. As earlier discussed, there is the danger that the burder of higher licence rates will be transfered by fishermen to the final consumers via imposition of higher prices for the catch.

h. Over the long-term, then, other measures should be considered by the fishery authorities (see e.g. Panayotou 1995; Pearse 1991). A management system similar to the ITQ in New Zealand and adjusted to acconodate local conditions, might work here.

i. Another management option which can be explored is to impose a restriction on the total effort in the commercial fisheries. First, total effort will be lowered gradually to MSY or MEY levels based on reduction percentages proposed in this and other studies. The reduction can be done in terms of fixed limitations in the number of boats by any acceptable composite measure of fishing effort. Then, the right to operate boats will be allocated through an open bidding system. Lastly, over time, these rights can be made tradable as in the ITQ system. It should be emphasized that a composite measure of the fishing effort is necessary to prevent the fishermen from substituting one input for another to circumvent limitations.

j. The use of the instruments in (d), (h) or (i) must be coupled with strong reforms in the enforcement side. In particular, the illegal underground economy in fisheries (e.g.

commercial operators using unlicenced duplicate boats) must be curtailed. Penalizing the offenders strictly according to law is likewise a necessity.

k. The problem of fishermen transfering the increased burden of the tax to the consumers ie real. If they can actually do this, it will be doubly difficult to reduce fishing effort. A way of solving this problem may be to strictly enforce some price controls, specifically in the wholesale market of fish. On the other hand, because of its high cost of administration and it being a hindrance to the operation of a free market, the use of price controls will need serious investigation.

l. Lastly, the problem of diplaced commercial fishermen once an effective effort reducing management scheme is in place will be a matter of serious concern. As many fishermen are uni-skilled, it will be difficult to employ the displaced in other economic sectors. Hence, a retraining and employment program will be needed. An option will be for the national government and private sector, e.g. Chamber of Fisheries, to pool their resources together to organize such a program.

11.2.2 Recommendations for Municipal Fisheries

For the municipal fisheries subsector, the following are the recommendations:

a. As overfishing also exists in the municipal fisheries, there is also the need to reduce from its present levels the fishing effort in this subsector.

b. An isolated policy to simply lower effort, however, through effort limitation for instance, will be politically difficult to implement. This is because municipal fishing is largely subsistence in nature and a matter of survival to fishermen. Forcing the fishermen out without an acceptable accompanying program to economically relocate them will be inequitable and morally unacceptable.

c. Because of (b), it may only be through the explicit provision of alternative livelihood opportunities to them that fishermen can leave the fishery. To effect this, small-scale livelihood programs can be promoted by the government in coastal areas in cooperation with the local government units and non-government organizations. Naturally, these livelihood promotion efforts will be accompanied by credit and training programs, and thus requires substantial public investment.

d. The promotion of econ-tourism in suited rural coastal areas is another way of promoting alternative livelihood opportunities for municipal fishermen. The more fishermen employed in the econ-tourism establishments, the less fishing effort will be. In addition, because of very nature, eco-tourism contributes to the effort to preserve local fishery resources.

e. Another option for the government is to encourage dispersion of industrial development into the rural coastal areas. The more industries and other economic activities that employ the municipal fishermen, the less likely that they will endulge in fishing activities. In addition, rural industrial development provides impetus for rural economic growth in general.

f. The promotion of the practice of coastal resources management in fishing communities is another means of reducing fishing effort. As municipal fishermen become aware of the dangers that overfishing brings to their economic welfare, the more likely they will practice sustainable fishins. The growing number of coastal resources management programs or projects in the country is a big step in the right direction and must be continuously supported by the government.

g. Finally, the fast implementation and operationalization of the Local Government Code in rural coastal areas will help promote effort reduction in municipal fisheries. As the code empowers local governments and people organizations to manage coastal resources in a sustainable manner, its actual implementation should result to the development by the local stakeholders of effective systems, such as those relating to coastal property rights and access; rules and ordinances; monitoring, policing and enforcement; penalties; and others that will result to the sustainable exploitation of municipal fishery resources.

11.2.3 Recommendations for Overall Marine Fisheries

For overall marine fisheries, the following recommendations may be considered:

a. As stated in the early parts of the study, overfishing in the marine fisheries has been brought about not only by increased fishing effort but also by the employment of destructive gears and techniques by fishermen. Hence, to help conserve marine fisheries resources, the effective enforcement of the fishery laws, rules and regulations related to destructive gears must be strengthened. In addition, new and more effective ways of countering the problem, such as deputization of stakeholders in local areas, must be extensively practiced.

b. While reduction of fishing effort is a primary concern in the marine fisheries, the impacts of such reduction in terms of equity must be given equal attention by the authorities. This point was already discussed for the municipal fisheries. For the overall marine fisheries, it is strongly recommended that a strong balance between efficiency and equity objectives must first be established before reduction in effort will be done. If in the end, for instance, a reduction will only result to the monopolization of the fisheries sector by a few efficient big-time operators, then sustainable development in the sector will have been attained at too stiff a price.

c. It is also strongly recommended that public revenues that will be had from fishing effort reduction be specifically earmarked for the development of the marine fisheries sector. This move will help gain the support of the fishery stakeholders for the effort reduction.

Furthermore, more public funded projects in marine fisheries means that the government is now putting its money where its mouth is.

d. In relation to (c), public revenues from effort reduction can be specifically utilized to assist the fishermen that will be displaced by the reduction. The funds can go into training programs or the development of alternative livelihoods for the fishermen mentioned earlier.

e. As indicated in this study, there may be several commercially important fish species that are underexploited at the present. Thus, the authorities should put as much effort into how these species can be exploited as to how overfished species can be protected. The optimal exploitation of all commercial species must be a prime goal in fishery management.

f. Lastly, all this talk about overfishing brings in the question of who are doing all the overfishing. Are the Filipinos the only ones doing the overfishing or are there others illegally overfishing in its waters? This point is crucial because any effort to curve overfishing by locals will be ineffective, and nationally inimical, if overfishing by others remain. While this is outside the scope of this study, it must be emphasized here that the problem of instrusion by foreign fishermen into local fishing grounds must be solved if the marine fisheries resources are to be sustainably managed.

To end, this study concludes that at this point in fisheries development, serious fishing effort reduction must be done if our marine fisheries resources are to last. However, the objective of sustainable development in fisheries must not be attained at the exorbitant price of imposing inequitous burden on poor populations who were forced by economic realities to hitch their lives on the future of the fisheries sector.

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